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SM 21 74

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LETTERS

Science for laymen

Sir, Articles in *S.R.* are informative, interesting and readable.

A person today cannot understand the world in which he is living unless he understands science. Science has begotten many sciences, and human knowledge has become too vast to be possessed by any one person. So, specialisation has become inevitable. All scientists/specialists should feel that it is their social obligation to spread the knowledge they have gained in specialisation for the benefit of the common man, particularly in a country like ours where 80% population is poor and cannot afford to provide academic education to their children and to themselves. And to this end, the writers of articles in your journal should write in a manner and style intelligible and understandable to a layman. The distressing aspect of the scientists/specialists is that they seem to feel that their knowledge is esoteric, unintelligible or ununderstandable to a layman. I am afraid either scientists are labouring under an inadequate talent to express what they have learnt or suffering from vanity!

I request you to introduce a chapter "Science for the layman" or extend your present chapter" Science for the Young" as "Science for the Young and Laypersons" and provide it with informative and intelligible articles.

H. V. NARAYANA RAO
D. No. 44/21-A, Prakasam Nagar
Kurnool 518004

Protein from petroleum

Sir, Apropos of **Protein from petroleum** by Dr. M. K. Sharma (*S.R.*, May 1976, pp 272-275) I would like to add some more points. But, before coming to these points it would be worthwhile to focus on the work done on single cell protein (SCP) in the CSIR Laboratories of India. Dr. M. K. Sharma has mentioned only the Indian Institute of Petroleum, Dehra Dun, in this regard, while Regional Research Laboratory, Jorhat, has also done a lot of work on single cell protein. Recently, Shri P. K. Barua of the RRL, Jorhat carried out studies on SCP and got his Ph.D under Dr. J.N. Barua; a report of this work has also been published in the *CSIR News*, Sept. 15, 1975 and *Science & Culture* Nov. 1975, Vol. 41, No. 11 in the article *Protein and vitamin concentrate from petroleum hydrocarbon*. Single cell protein not only serves as a rich source of protein but also of vitamins. In India, it is possible to produce about 0.12 million tonnes of pure protein by diverting only 5 % of the internally derived crude petroleum. Dr. J. N. Barua *et al*, of RRL, Jorhat have given detailed information about petroleum hydrocarbon utilizing bacteria which was published in *J. Scient. Ind. Res.*, *Vol* 34, No. 11, Nov. 1975, pp 614-624.

SCP is basically composed of proteins, fats, carbohydrates, ash ingredients, water, nucleic acids vitamins and other substances. The specific composition depends on the particular organism and the feed stock on which it grows.

It is however necessary to remove most of the nucleic acids. This post-treatment therefore involves a variety of techniques to solubilize the nucleic acids. Most popular substrates are either normal paraffins or alcohols. Former is lower in cost and gives a higher yield of biomass than alcohol, but it requires additional energy input for oxygen transfer. Alcohols are already partly oxygenated. Paraffins have a higher enthalpy and so an increasing cooling requirement.

In case of feed it is not necessary to remove nucleic acids because they are not harmful to animals. But in the case of human food more than two grams of nucleic acid intake is not suggestive, if reasonable uric acid level is to be maintained to avoid uric acid poisoning and gout. Hydrolysis can reduce the nucleic acid level, which if properly done, will not denature proteins in the SCP and will increase the total protein.

SCP has a PER (protein efficiency ratio) between 2 and 3 compared to 3.00 of caesin. SCP has a high nutritive value than comparable quality soy-protein and hence can have particular utility for fortifying food products.

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Parity conservation (*S.R.*, March 76)

Sir, I would like to present the most important implications of Madame Wu's experiments which were responsible for the downfall of parity. The experiments provided a solution to the Ozma problem—an experimental method of extracting from nature an unambiguous definition of left and right. All that is necessary is to cool the Co 60 atoms near to absolute zero and line up their nuclear axes with a powerful magnet. Count the number of electrons flung out by the two ends of the axes. The end that flings out more electrons is the end we call 'south'. It is now possible to label the ends of magnetic axes of the field used for lining up the nuclei and this in turn can be used for labelling the ends of a magnetic needle. Put such a needle above a wire in which the current moves away from you. The north pole of the needle will point to the direction we call 'left'. Q solution to the Ozma's problem is obtained.

The fall of the parity was an evidence against the symmetry which was accepted to exist in the physical realm. Q suitable insight into this asymmetry is expressed in these words by the well-known physicist, R. P. Feynman (*Feynman Lectures in Physics*, Vol. 1, Adison Wesley).

Why is nature so nearly symmetrical? No one has any idea. The only thing we might suggest is something like this. There is a gate in Neipo, Japan, described by Japanese as the most beautiful gate in the world. The gate is elaborate with lots of gables and beautiful paintings. But when one closely observes it he sees, in the midst of all these designs, one of the small design elements is carved upside down; otherwise the thing is completely symmetrical. If one asks why, the story is that it was carved upside down so that gods will not be jealous of the perfection of man and get angry with him.

We might like to turn around and think that the true explanation of the near symmetry of nature is this: God made the laws only symmetrical so that we should not be jealous of His perfection.

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Even after agreeing with the first half of the letter, it can be emphasized that the far reaching consequence of the result of the experiment conducted by Madam Wu *et al.* already remained implied in the theory of Lee and Yang. The situation can be explained in the following way: All theories of decay had been constructed under the assumption that parity was conserved. These theories were in reasonable agreement with experience and so it was generally believed that our experience indicates parity conservation in decay interactions. This reminds us of the famous logical error : All horses have four legs; this has four legs, therefore this is a horse. However, it was left to Lee and Yang to show first that experiments which had been done were equally consistent with the nonconservation of partiy. The first experiment designed to detect possible effects of the absence of left-right symmetry in decay interactions was done by Wu *et al.*

From this experiment, it is possible to abandon the hypothesis that the weak interactions were invariant under left-right symmetry. One could now explain the different decays of the now-one particle $(\zeta, \theta = K)$. As the parity is not conserved in the decay process, the same particle can decay in two different ways into two states of opposite parity. In this way, a new range of experimental possibilities opened up.

As regards the second half of the letter, it must be noted that the advocacy of the idea that God has made near symmetry in nature just to make compromise with us, expresses one's own personal feeling and can have no scientific basis. Moreover, it is not clear why we should be jealous at all. In this context, it is interesting to remember the witty correspondence between Pauli and Weisskopf. 'I do not believe', wrote Pauli to Weisskopf on January 17, 1957, before the results of Wu *et al.* were made public, 'that the Lord is a weak left-hander'. A few days later he wrote again, 'I am shocked not so much by the fact that God is a left-hander, but by the fact that he still appears to be left-right symmetric when expressing himself strongly'.

TAPASH CHAKRABORTY
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Monopole

Sir, I read the **Elusive monopole** (*S.R.*, Feb. 1976) with great interest.

I have found that if a magnetised needle is heated at one end, the polarity of the heated end is very much reduced, while the other end retains the polarity. That is, it behaves more or less like a magnet with a single pole. This phenomenon may have something to do with monopole. I will be grateful to have comments of Shri Chakraborty on it.

GURDIP SINGH
Amritsar

The problem has a very simple explanation : when we heat one end of a magnetized needle, we first reduce its remanence or magnetic 'hardness', causing it to become demagnetized. However, it will still remain magnetic, but soft.

In the process of heating, as we approach the Curie temperature (about 700°C for steel), ferromagnetism will vanish and the material will behave only weakly paramagnetic. The susceptibility will decrease as the temperature is further raised in proportion to $1/T$, ($T=$ absolute temperature), according to the Curie law.

Magnetic flux lines will begin to leak out of the needle before they reach the heated end as shown in Fig. 1. Therefore, the needle will develop a distributed magnetic pole instead of one concentrated at the needle point. The unheated end will remain a magnetic pole.

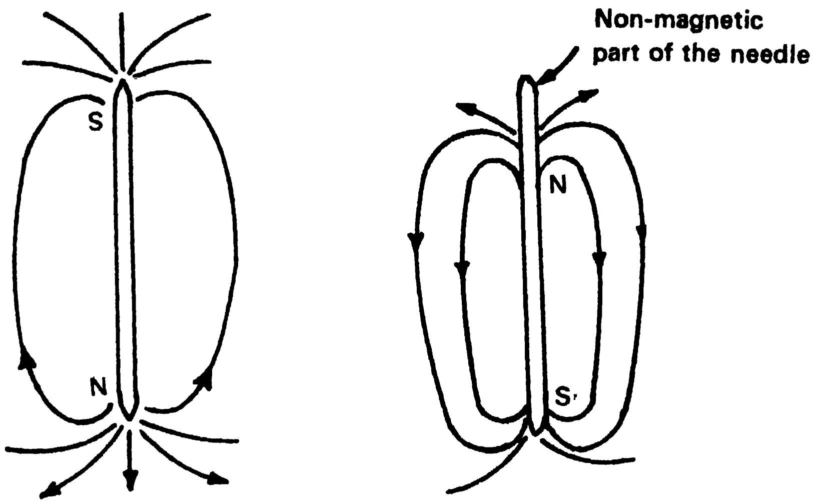

Fig.

Flux lines around magnetized needle under normal conditions

Flux lines around magnetised needle when the upper end has been heated to near its Curie temperature (about 700 °C)

This asymmetry, as explained above, may create the impression of a monopole, since the magnetic attraction for iron flints, for instance, is proportional to the field and field gradient, that is, the density of flux lines and their divergence. The distributed pole will therefore show little attractive effect compared to the concentrated one.

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Electrical events in heart beat

Sir, Although T. S. Gill's attempt at elucidation of the **Electrical events in the origin of heart beat** is admirable (*S.R.*, April, 1976), it requires some comments. The pacemaker of the heart comprising of the sino-auricular node is situated at the junction of the superior vena cava and the right auricle of the mammalian heart and not simply in the wall of the right atrium. The article states that "At rest the pacemaker cells.... are polarised" implying that these cells have a definite resting state, although a special feature of the pacemaker cells is that they are *never resting*. The maximum transmembrane potential in these cells is around −55 mV as against 1/10 volt (or 100 mV) as suggested by Gill. The Na$^+$ ions rush in when the maximum membrane potential reaches −40 to −45 mV, not 1/600 volt or 1.66 mV as given in the article. This influx of Na$^+$ ions should, however, not be called an electric spark by any stretch of imagination but at best an impulse, as it signifies the beginning of a signal for the cellular functions. Sodium-pump, the energy dependent process for the extrusion of Na$^+$ from the cell interior to restore the cell membrane to its normal state, is not a specific feature of the myocardial cells but takes place in all the living cells. Moreover, it is not yet experimentally proven that the electrical impulse reaching the myocardial cells triggers the breakdown of ATP.

Gill's suggestion that an increased temperature during fever increases the heart rate by increasing the membrane permeability to Na$^+$ ions seems highly speculative. Although it is known from *in vitro* experiments with the atrial pacemaker that an increase in temperature increases its rate of beating, the situation *in vitro*, may be quite different, as a number of other changes during high fever could as well account for the increase in the heart rate. The well-known disturbances in the rhythm of heart beat, for example, arrhythmias and dysrrhythmias are basically due to an alteration in the electrical characteristics of the myocardial cell membrane including those of the pacemaker cells; a lack of co-ordination between the s.a. and a.v. nodes may be one of the many causes, rather than the sole cause, for such disturbances as mentioned in the article. The diagram showing the potential changes at a pacemaker cells is rather out of proportion and requires proper labelling of the different phases of action potential as well as that of the voltage levels. Moreover, the numbers of the open and filled circles representing the Na$^+$ and K$^+$ ions respectively are not constant in each circle indicating the possibility of actual loss or gain of these ions which does not happen in the normal living cells.

O. N. TRIPATHI
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Heavy metals

Sir, Though excessive concentrations of some heavy metals (*S.R.* May, 1976) are toxic, a fairly large number of enzymes contain metal atoms as integral parts of their structures; they are tightly bound and are necessary for the activity of the protein. Some other enyzmes are activated by the addition of metal ions. Some of the important enzymes which require heavy metals for their normal activity are given below :

Copper	.. Tyrosinase, Phenolase, Ascorbate, Oxidase, Tryptophan 2, 3-dioxygenase

Molybdenum	.. Xanthine oxidase, Nitrate reductase (plants),
Iron	.. Catalase, Peroxidases, Cytochrome enzymes, Homogenitisicase
Zinc	.. Carbonic anhydrase, Lactate dehydrogenase, Carboxypeptidase, etc.
Manganese	.. Arginase, Acetyl CoA carboxylase, etc.
Cobalt	.. Peptidases, Aldolases, ALA synthetase, Transcarboxylase, etc.

Besides, when selenite is added to experimental rations it affords complete protection against liver necrosis.

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Protein

Sir, Solving the much discussed protein problem by obtaining proteins from petroleum is rather fascinating (*S.R.*, May 1976), but to say that the main deficiency in the diet of roughly half the world's population is animal protein is incorrect. Animal protein, though good, is not essential. To say that essential amino acids such as lysine are present only in animal foods is again wrong. Pulses contain a high content of lysine which is limiting in cereals like wheat and rice. Hence a combination of the two gives a favourable amino acid composition. In fact, in these days of shortages, animal food is being largely discouraged by nutritionists all over the world because of its increased cost of production. Apart from petroleum, leaf and mushroom are good potential sources of protein.

Poonam Chandra
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M. S. University, Baroda

Pi

Sir, Dr. S. K. Mukherji has given (*S.R.*, June 1976) the value of π upto corrected 20 places of decimal as 3.14159265358979323846. Incidentally this reminds me of the following verse, though not very elegant, which we had picked up in our college days, correct upto as much decimal places :

Sir, I bear a rhyme excelling
In mystic force and magic spelling
Celestial spirits elucidate
All my own striving can't relate.

S. K. Gurtu
Defence Science Laboratory
Metcalfe House
Delhi-110054

Back issues of S.R. wanted

Sir, I want to buy all the issues of *S.R.* preceding 1973. So, subscribers of *S.R.* interested in selling these back issues of *S.R.* may contact me.

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Bhilainagar-490001 (M.P.)

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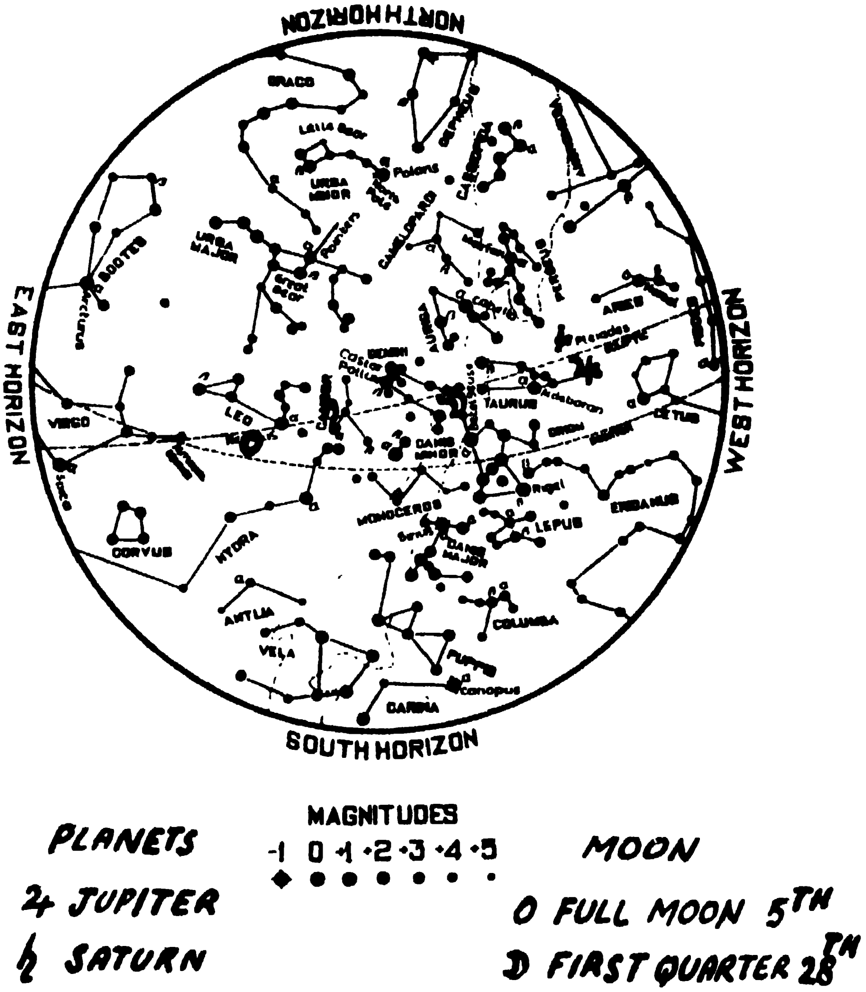
Planets and their positions

MARCH 1977



FULL moon occurs on 5th at 10-43 p.m. and new moon on 20th at 0-03 a.m. I.S.T. The moon passes about six degrees south of Saturn on 3rd, about five and a half degrees north of Mars on 17th, eight degrees south of Venus in the evening of 21st, about two degrees south of Jupiter in the night of 24th and again six degrees south of Saturn in the night of 30th. The lunar crescent becomes first visible after the new moon day in the evening of 21st. The moon is at perigee or nearest to the earth on 9th and at apogee or farthest from it on 25th.

The Sun is at the vernal equinox on 20th.

The planets

Mercury (Budha) is too near the sun to be visible during the first three quarters of the month. It is in superior conjunction on 16th. Thereafter, it reappeares as an evening star and sets about an hour after sunset. It passes about eight degrees south of Venus on 28th. It moves from Aquarius (*Kumbha*) to Aries (*Mesha*) through Pisces (*Mina*). Its visual magnitude is about -1.2.

Venus (Sukra), an evening star, sets about two and a half hours after sunset during the first half of the month and about one and a half hours after it during the second half. It attains the greatest brilliancy on 1st and become retrograde on 16th. It moves from Pisces (*Mina*) to Aries (*Mesha*) and thence again to Pisces (*Mina*) by retrograde motion. Its visual magnitude varies from-4.3 to-3.5.

Mars (Mangala), visible in the morning sky, rises about one and a half hours before sunrise during the month. It moves from Capricorn (*Makara*) to Aquarius (*Kumbha*). Its visual magnitude is about + 1.4.

Jupiter (Brihaspati), visible in the evening sky, sets about one and a half hours before local midnight during the first half of the month and about two hours before it during second half. It is in Taurus (*Vrisha*). Its visible magnitude is about—1.7.

Saturn (Sani), visible in the evening sky, sets about two hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It is in Cancer (*Karkata*). Its visual magnitude is about +.0.3.

(*Source*: Nautical Almanac Unit of the Meteorological Office, Alipore, Cal.-27)

The work on deciphering the genetic code was completed in the last decade. The classical experiments of that era and the revolutionary concepts they produced are reviewed

THE GENETIC CODE-REVISITED

J. PHILIP RYAN

JUST over 100 years ago in 1866, Gregor Mendel made the basic discoveries that established genetics as a science. Some 50 years later, Morgan and others (1915) demonstrated the physical existence of the gene, and its linear arrangement on the chromosome. More recently, Benzer (1961) has clarified the idea of a gene by some brilliant mutational analysis, which permitted the recognition of a unit of function called the cistron. Cistrons are defined as the smallest units of genetic material which can complement each others function. If a diploid cell has two chromosomes which are defective in the same cistron, then it will lack at least one particular function. If, on the other hand, the two chromosomes are defective in different cistrons, then both functions will still be expressed in the cell. In other words, each cistron codes for one complete message—the primary structure of a polypeptide chain. A cistron may be considered as a definite sequence, of from some 1000 to 1500 nucleotide pairs in a DNA-molecule. This nucleotide sequence contains the genetic information required to direct the synthesis of a definite protein molecule. Now, the question to be considered here is how does the cistron code for a particular protein? This is the problem of genetic coding.

The discovery of the structure of the gene was a very gradual process, but once the genetic material was shown to consist of pure nucleic acid the first major step had been taken. All that remained was to decipher the code itself. In theory, a simple and direct comparison of a nucleic acid (cryptogram) and the protein (cleartext) it coded for, should yield the secret of the code. However, this cannot readily be done in practice, so more

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indirect experimental approaches had to be used. The evidence derived from all these indirect methods (together with some amazingly simple thinking) has revealed without doubt that the genetic coding sequence is linear but non-overlapping, and is uni-directionally transcribed in the 3′→5′ direction and translated in the 5′→3′ direction. It has also shown that the code itself is registered in consecutive, comma-free, triplet (triple ribonucleotide) codons, which are degenerate but not ambiguous, and for the most part universal in nature. Let us consider the evidence piece by piece.

The coding sequence is linear

Perhaps one of Nature's most elegant demonstrations of the linear arrangement of genes on the chromosome is the phenomenon of conjugation in certain bacteria. The process involves conjugation between two cells, and transfer of pure DNA from one (the male cell) to the other (the female cell), which normally takes upto 100 min. at 37°C. The transfer can be interrupted at any stage by mechanical agitation which breaks the DNA chain at that point. A fixed end of the chromosome is always transferred first, hence some of the genes are transferred before others. Chromosome mapping of the transferred genes can thus be studied at various time intervals, and have confirmed the linear arrangement of genes as arrived at by the analysis of recombination frequencies. At a finer level of resolution, the intracistronic coding sequence is also linear.

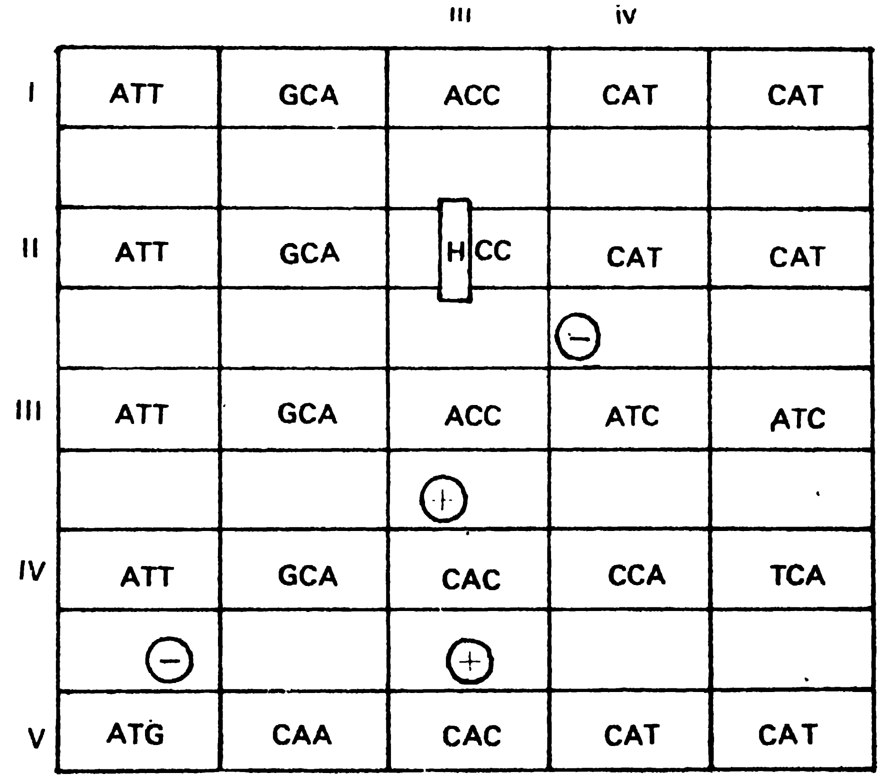
The mutagenic effects of acridine have been shown to depend on the insertion (+) or deletion (—) of single base-pairs during DNA-replication (Ames and Whitfield, 1966). Insertion or deletion of one base-pair generally leads to a completely non-functional gene. This type of phase-shift mutation causes the reading frame to be completely upset (Fig. 1). When two such mutants are genetically crossed, double mutants may arise if crossing-over occurs between the mutant sites.

Crossing-over between two insertion or two deletion mutants will lead to double mutants (+ + or— —) with the reading frame still misplaced. However, recombination between an insertion and a deletion mutant will yield a double mutant (+ — or — +) with the reading frame correctly aligned, except for a small region between the two error positions. In general, this produces a short sequence of incorrect amino acids in the protein produced.

The fact that single-point insertion or deletion mutants can allow the synthesis of only part of the total protein normally coded for, indicates that the code is read linearly in sequence until the error position is reached. However, the fact that only one end of such molecules can be synthesised from single-point mutations indicates that the code is only read in one direction.

The coding sequence is non-overlapping and comma-free

Simple base-pair switches or substitutions often lead to what are termed "leaky" genes, which have some activity. Nitrous acid has the mutagenic property of promoting the transitions: Adenine→ Hypoxanthine (which pairs like



			iii	iv	
I	ATT	GCA	ACC	CAT	CAT
II	ATT	GCA	HCC	CAT	CAT
				⊖	
III	ATT	GCA	ACC	ATC	ATC
			⊕		
IV	ATT	GCA	CAC	CCA	TCA
	⊖		⊕		
V	ATG	CAA	CAC	CAT	CAT

Fig. 1. The effect of various mutations on the sequence of nucleotides: I. a normal sequence of DNA, II. a base-switch mutation, converting adenine to hypoxanthine (which pairs like guanine). Amino acid in the iii position is switched from tryptophan to argenine III. a deletion mutation, which upsets all amino acids after the iii position, IV. an insertion mutation which upsets all amino acids after the ii position, V. a single deletion and insertion mutation, which upsets only the three amino acids in positions i, ii and iii respectively.

Guanine), and Cytosine→Uracil (which pairs like Adenine). Single substitutions invariably cause only one amino acid in the original polypeptide sequence to be changed. Many proteins of widely differing functions are now known to exist in several forms. Families of such proteins, with only one or two differing amino acids, include human haemoglobin, TMV (tobacco mozaic virus) coat protein, and the isozymes (iso-enzymes) of tryptophane synthetase from *E. coli*. The evolution of proteins, possibly caused by simple mutations at single base-pairs, can be traced in this way, cytochrome c being the classical example. If the coding sequence was overlapping then each base transition should be expected to cause more than one amino acid error, simply because (as we shall see) more than one base is necessary to specify each amino acid. But this is never found to occur in practice.

In contrast, it is conceivable that the code could contain a space between each signal or word. Such commas could assist in the reading process to correctly align the active codons. However, this device is unnecessary and has not been adopted in the genetic code.

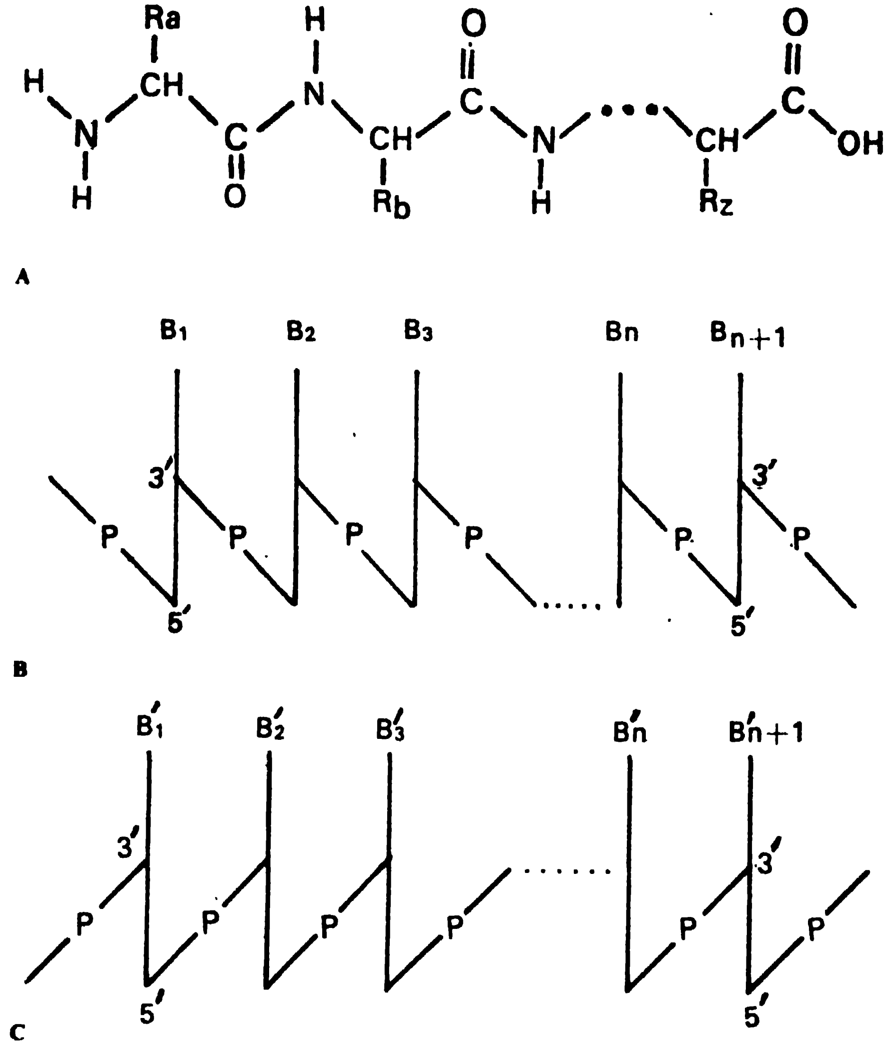


Fig. 2. General representation of protein and nucleic acids: (A) amino acid sequence in a protein molecule, (B) nucleotide sequence in mRNA molecule, (C) nucleotide sequence in a DNA molecule (which gives rise to the above mRNA)

The coding sequence is unidirectional

We are accustomed to reading English from left to right across a page. The Chinese is read from right to left. These are matters of convention. However, in proteins and nucleic acids there is a fundamental difference in the chemistry of alignment when reading in different directions. In the usual convention, protein sequences are written with their free amino (NH_2—) on the left and the corresponding free carboxyl (—COOH) group on the right. Nucleic acids, however, are normally written with the 5′— carbon of ribose (or deoxyribose) sugar on the left, and the 3′ — carbon on the right. These structures are illustrated in Fig. 2. The question is, are these directions compatible?

A single stranded co-polymer (synthetic mRNA) consisting of a repeating AAA-sequence and ending with an AAC-triplet at the 3′-terminus was tested *in vitro* to clarify this problem. The co-polymer was found to code for peptides consisting of repeating lysyl-residues and usually ending with an asparagyl-residue. This unique residue always occurred at the free carboxyl-terminal of the chain. It was concluded that the genetic information is translated unidirectionally in the 5′→3′ direction (conventionally read from left to right). In other words, the codon on the left of the mRNA sequence always codes for the N-terminal amino acid, and its opposite partner on the right codes for the C-terminal one. It was sheer good luck that the directions in which these two molecules are usually represented, correspond directly with each other! In other words, the two sequences are co-linear.

So, translation from mRNA to protein occurs in the 5′→3′ direction but, because of the inherent complementarity of nucleic acids; transcription of the mRNA from the original structural gene must, therefore, occur in the 3'→5' direction! This is indeed true and raises an interesting question. We know that DNA consists of a duplex [double, plectonomically coiled (pleated) complementary, anti-parallel, right-handed helices,] with the bases of each chain projecting perpendicularly towards a central common axis, where they are stabilised by hydrogen bonding (Watson and Crick, 1953). Furthermore, the base composition of these twin chains is such that adenine pairs only with thymine, and cytosine pairs only with guanine. Thus a unique property of the DNA duplex is that one chain is an exact complement of the other and runs in the opposite direction. In other words, if one chain is represented in the 5'→3' direction, its complement must of necessity be given in the 3'→5' direction. Now, if the genetic information is encoded in the actual base sequence of the nucleic acid, the question arises which chain is it actually encoded in? Because of the base-pairing complementarity, only one sequence can give rise to a functional mRNA. The other sequence can, of course, give rise to a dud mRNA which may even code for a non-functional protein, and in fact often does so *in vitro*. But, *in vivo*, the cell, being economical, limits the process of transcription to the functional sequence only. Incidentally, (and, indeed, because of the one-to-one base pairing rules) each DNA chain must in fact carry exactly the same amount of genetic information. This is obvious when it is considered that each chain gives rise to an exact copy of the other during the replication process. However, while the amount of information may be the same quantitatively speaking in both DNA chains, it is so encoded that only one of these chains is directly decipherable in the cell. And whichever chain this might be, it must be transcribed in the 3'→5' direction.

The code is registered in consecutive triplet codons

Only 4 bases are used in the synthesis of DNA or RNA, so there cannot be a one-to-one correspondence between the nucleotide bases and the amino acids, simply because there are more amino acids than bases. About 20 different amino acids can be used in the synthesis of natural proteins. So there are 20 items to be coded for, but only 4 types of sign. Taken singly then, the bases can only be chosen in 4 ways. Dinucleotides (pairs of adjacent bases), however,may be arranged to give a total of 16 possible signals—this also falls short of the required number. On the other hand, a total of 64 different trinucleotide codons (signals) can be formed from 4 different bases (signs). This could allow any of three possibilities. The genetic code could be degenerate, redundant, or overlapping! It is now known that the code is, in fact, degenerate, having upto 6 synonymous triplet codons for some amino acids. Indeed, all of the 64 codons have their assigned meanings, hence the code is not at all redundant. Nor, indeed, is it overlapping, as we have seen (although, theoretically it is possible to devise such a code; admittedly with some necessary constraints on the allowable sequences of amino acids). The code is also comma-free, in the sense that the codons are arranged in consecutive triplets, In other words, none of the bases are employed as codon spacers.

In a sequential code which is non-overlapping and comma-free another problem arises, that of correctly registering the codons. At first it was thought that the triplet code might be redundant rather than degenerate. Indeed, it is possible to devise a redundant code for the 20 amino acids, leaving 44 nonsense triplets. But while this is a clever ploy it lacks evolutionary flexibility, and has the inherent danger that most mutations would be lethal. Nature is found to be more cautious, in that the mRNA message is read (registered) in consecutive triplets starting from the 5'-end of the molecule (often starting at a polypeptide initiator codon) and proceeding to the other end (unless a polypeptide terminator codon intervenes). Although it is better at doing this *in vivo* than *in vitro*, but this is understandable!

It was Gamow (1954), who first suggested that each codon probably consists of three successive bases. All the evidence since that time has supported this idea. Crick (1962), and many others, in experiments with the B cistron of the r II region of the T_4 bacteriophage, have shown that the triplet codon is indeed the most likely. It was found possible to obtain functional genes with three closely spaced (not necessarily adjacent) insertions (+ + +), or deletions (— — —), or with one insertion and deletion in the same gene (+ — or — +). All other single, double, or triple combinations were defective. Even four such single-point mutations in a single gene gave a non-functional gene (except in cases where there were two insertions and two dele-tions). The conclusion is obvious.

Further evidence for the triplet. codon is derived from the fact that homo-polypeptides can be synthesised from ordered polyribonucleotides, such as co-poly (UUC), which consists of repeating UUC-triplets. It is possible to register three different codons in this co-polymer,

Table 1. The genetic code dictionary

First base (5'-end)	Second base								Third base (3'-end)
	U		C		A		G		
U	UUU	*Phe*	UCU	*Ser*	UAU	*Tyr*	UGU	*Cys*	U
	UUC		UCC		UAC		UGC		C
	UUA	*Leu*	UCA		UAA	*Stop* †	UGA	*Stop* †	A
	UUG		UCG		UAG		UGG	*Try*	G
C	CUU	*Leu*	CCU	*Pro*	CAU	*His*	CGU	*Arg*	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	*Gln*	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	*Ile*	ACU	*Thr*	AAU	*Asn*	AGU	*Ser*	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	*Lys*	AGA	*Arg*	A
	AUG*	*Met*	ACG		AAG		AGG		G
G	GUU	*Val*	GCU	*Ala*	GAU	*Asp*	GGU	*Gly*	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	*Glu*	GGA		A
	GUG*		GCG		GAG		GGG		G

*These codons are also known to function in polypeptide initiation.

†The polypeptide terminating codons have been named as follows : Amber, UAG; Ochre, UAA; and Opal UGA.

Full details are given in the text. Each triplet represents one mRNA codon and is written in the conventional 5'→3' direction.

namely UUC, UCU or CUU. Indeed, co-poly (UUC) is found to code for polyphenylalanine, polyserine, and polyleucine, *in vitro*. It does not, however, code for heteropolymers of these three amino acids, which is evidence to show that the coding is comma-free.

On the other hand, the random co-polymer of U and C, in the same 2:1 proportions, is found to code for a random heteropolypeptide consisting of the 4 amino acids: phenylalanine, serine, leucine and proline in the proportions 4 : 2 : 2 : 1, respectively. Each amino acid in this particular example has, in fact, two synonymous triplet codons because of the degeneracy of the code (Table 1). The relative frequency of each codon and hence amino acid, depends on the base composition. A worked example is given in the next section.

Of course, it is conceivable that cells could have evolved codons consisting of 4 consecutive bases (or even more): but cells in general are as efficient as possible, and would hardly require an alphabet of 256 (or more) symbols to specify just 20 items.

Code is degenerate but not ambiguous

The fact that there are 64 codons and only 20 amino acids raises the question whether all the possible signals are used or not. The first synthetic polyribonucleotide discovered to have mRNA activity was poly(U), a homopolymer of uracil bases. Nirenberg and Matthaei (1961), found that it could exclusively select phenylalanine residues. This discovery revealed the codon for phenylalanine. Whenever a sequence containing three uracil bases was registered (UUU codon) in the mRNA sequence it could be predicted that phenylalanine would be incorporated into the protein chain. Similarly three adenine bases (AAA codon) were shown to code for lysine residues, and three cytosine bases (CCC codon) were shown to code for proline residues. Unfortunately, poly (G) is subject to hydrogen bonding, which forms triple stranded helices which cannot bind to ribosomes, and hence cannot act as a message. The corresponding amino acid for the GGG codon had to await further techniques before it could be discovered. It was eventually shown to be glycine.

Random mixed polymers, such as co-poly (A, U) can contain upto 8 different triplet codons, whose frequencies depend on the constituent base proportions. Random co-polymers have been shown to give rise to heteropolypeptides with various amounts of different amino acids (Nirenberg, 1963). Even though these experiments cannot reveal the order of nucleotides within the codon, they are important pointers in deciphering the code in doubtful cases. The theoretical probabilities of finding particular codons can be readily calculated if the base proportions are known. For example, if the random co-polymer co-poly (C, G) contains C and G in the proportions 3 : 7 (i.e., 30% C and 70% G), then the probability of occurrence of, say, the GCG-codon will be given simply by the product 0.7 × 0.3 × 0.7 = 0.147. In other words, approx. 15% of the codons can be expected to consist of the GCG-triplet. Now this codon is specific for alanine. But, the GCC-codon has also been found to code for alanine, and this codon will occur (by the same reasoning) some 6% of the time. So, in general, alanine can be expected to occur some 21% of the time in the heteropolypeptide coded for by co-poly (C, G) ; (3:7). Various other possibilities are worth computing, with reference to Table 1.

Khorana and others (1966) developed synthetic but regular co-polymers. Co-poly (UG) for example, which consists of the sequence-U-G-U-G-U-G-U-G-U-G-U-G, was found to direct the synthesis of the regular heteropolypeptide -cys-val-cys-val-, and thus confirmed that the cys-codon was UGU, and the val-codon was GUG. Numerous examples were investigated in this way.

On the other hand, Nirenberg and Leader (1964), showed that the binding of various triribonucleotides to isolated ribosomes was sufficient to promote the attachment of particular tRNA molecules (which are specific carriers for the 20 different amino acids). All 64 triplets were tested in this way, and about 50 of them gave unambiguous results. The actual method involved passing the mixture over a nitrocellulose filter which retained the ribosomes and any attached molecules. Therefore, all but one type of tRNA passed through the filter, and with them all the corresponding amino acids. The .emaining amino acid could then be detected.

The results were all in agreement, whatever the method of investigation used, and very quickly all the codon assignments were worked out as shown in Table 1. Of these 61 codons are used to specify the 20 amino acids. The remaining 3 are actually used as polypeptide chain terminators (stop signals). These have been nick-named (on the bases of mutation studies) as follows: Amber (UAG-codon), Ochre (UAA-codon), and Opal (UGA-codon), respectively.

All the amino acids except methionine and tryptophan (which are believed to be evolutionary late-comers) are selected for by more than one codon, with the synonymous codons differing mainly in the 3′-terminal nucleotide. Even the stop signal is degeneratel The existence of these synonyms (upto 6 for some amino acids) does not necessarily mean that the code is randomly degenerate, nor indeed does it imply a lack of specificity. It is possible that some codons are only specific for certain tRNA molecules (if not different amino acids). *E. coli*, for example, contains two types of tRNA for transporting leucine, one of which only recognises the UUC-codon. However, it is now known that many tRNA molecules can recognise several codons, often with differing affinities. But, this observation itself is suggestive. Again, when the nucleotide sequence of various tRNA molecules became known, it was shown that only the first two bases of each mRNA codon were fully specific for the corresponding tRNA anticodon. A certain latitude was allowed in pairing at the third position. This became known as the Wobble Hypothesis (Crick, 1966), and helped to clarify many formerly puzzling effects. It particularly explained why the synonymous codons are found in the same 'box' of the table (see Table 1.).

But even if we allow that the code is degenerate (even in an unqualified way), it is by no means ambiguous. Ambiguity can arise in messages when the noise-to-signal ratio becomes high. The analogy of noise may occur even at the molecular level of the genetic landscape. The presence of high concentrations of such simple cations as Mg^{++} and NH_4^+ causes mis-reading of various condon assignments. Under such conditions, the UUU-codon can select a little leu-tRNA as well as its normal phe-tRNA. Even the initiator codon, if present, can be suppressed by high Mg^{++} levels and this can cause the reading frame to be upset. Antibiotics, such as streptomycin, also cause mis-reading. Even certain genes in the cell can cause reading mistakes (sometimes to advantage!). For example, there are suppressor genes which insert specific amino acids at various terminator codons. Now, if such codons arose by mutation in the first place at some point in an important cistronic message, then the second mistake can be used to rectify the first. Thus a certain amount of background noise even at the genetic level may be of evolutionary advantage as a buffer against the unpredictable visisitudes of even some single-point substitutions. However, under conditions *in vivo* the code is almost certainly unambiguous, and is translated in error-free messages of perfect fidelity. At the same time it should be noted that many small peptides such as glutathione (and -glutamyl-cysteinyl-glycine), and even some antibiotics such as the decapeptide Gramcidin S., in *B. brevis*, are produced without the aid of genetic coding.

Two apparent exceptions to the unambiguous nature of the genetic code are shown by the met-codon (AUG), and the val-codon (GUG). These can also serve as polypeptide chain initiating signals. In *E. coli* and yeast, the AUG-codon is found to initiate protein synthesis by coding for N-formyl-methionine. This step also helps to register all the subsequent codons. Indeed, there is evidence that the AUG-codon can determine the reading frame even when it does not actually occur on the 5′—terminal of a synthetic co-polymer. It is believed that completed polypeptides are subsequently hydrolysed to remove the N-formyl-methionine residue (and possibly even other amino acids as well), or at least the formyl-group. Again, the direction of translation can be confirmed by using co-polymers with an AUG (initiator) triplet at one end and an UAA (terminator) triplet at the other with assorted bases in between. In higher organisms (some animals), GUG appears to function as an alternative polypeptide initiator codon signal. But, here again, the term ambiguity is inappropriate for the apparent duplicity of codon function, because terminal and internal codons may differ in function, and at least in the case of the AUG-codon there are again two distinct tRNA species: one which is specific for N-formylmethionine, and the other for methionine itself!

DNA SEQUENCING: A NEW METHOD

HOW is the information coded in those parts of DNA that are not structural genes? To find an answer, one has to determine the nucleotide sequences of these regions.

The RNA sequencing method, however cannot be applied because of three reasons. Firstly, the radioactive labelling of specific DNA segments *in vivo* is not known. Secondly, there are no known DNA degrading enzymes that may cleave at specific bases. Lastly, even if such enzymes were found, they would cut the DNA molecule into so many pieces which would be difficult to separate.

Until recently, sequencing of nucleotide only in a very few short DNA segments was known, but this method could not be utilised for many naturally occurring DNA segments.

In the last two years, simple methods to determine the DNA sequencing have been developed. One of the techniques uses restriction enzymes obtained from bacteria. Each restriction enzyme recognizes a specific DNA sequence and cuts the DNA at that sequence. According to R. Roberts of Cold Spring Harbour Laboratories, U.S.A., out of 300 bacterial strains he analysed, one third produced restriction enzymes. Nearly 45 enzymes of separate specificities have been found out. Once short DNA segments are obtained, it is easy to label them radioactively (*Science*, Vol. 192, 14 May 1976).

N. B.

The code is universal

Although the code is universal in principle, it may nevertheless contain some regional dialects. Preference for certain synonyms of the degenerate assignments is one possibility. Indeed, we have seen how this may even apply to the initiating and terminating signals as well. An elegant experiment illustrating the relative response of different tRNA species derived from widely divergent organisms such as *E. coli* (bacteria), *Xenopus laevis* (amphibia),a nd —uinea pig (mammalia), was carried out by Nirenberg and his colleagues (1966). Some synonymous codons were equally popular templates with tRNA, whatever its source; whereas in other cases the codons were only active with the tRNA from one but not the other sources. However, tRNA from different tissues (such as liver and muscle) in the same species always gave the same response.

Other points in favour of the universal nature of the genetic code derive from the great uniformity of the primary structures (amino acid sequences) of homologous proteins, such as cytochrome c, from divergent species (which could reflect a common phylogenetic origin). Again, DNA (hence mRNA) with a high guanine and cytosine content is usually found to give rise to proteins which are rich in alanine, argenine, and glycine, but poor in isoleucine, lysine and phenylalanine. If the code is universal, a comparison of the corresponding codon-assignments for these amino acids (Table 1) should be sufficient to explain this observation. Finally, any mutation which could result in altered codon assignments would almost certainly be lethal; because it would actually change the nature (if not the amount) of the coded genetic information, and result in nothing but "scrambled" proteins, if indeed any at all! So perhaps it is pertinent to conclude here, with a quotation from Nirenberg (1966), who contributed so much to breaking the genetic code :

"The remarkable similarity in codon base sequences recognised by bacterial, amphibian, and mammalian tRNA suggest that most. if not all, forms of life on this planet use almost the same genetic language and that the language has been used possibly with few major changes, for at least 500 million years".

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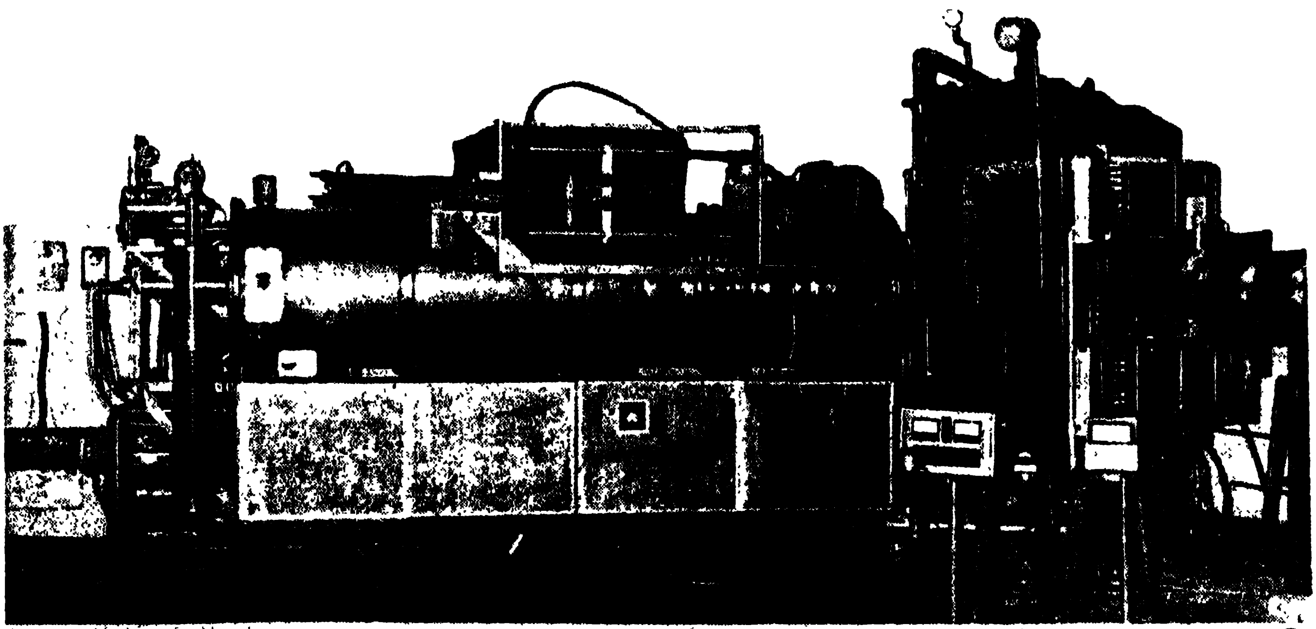

Cyclotrons: The machines of Nuclear physics

The "atom smashing" machines, originally invented for nuclear research, are now finding extensive use in production of radio isotopes and in many other fields such as medicine and material science

NARESH KUMAR

EVER since the discovery of nucleus in an atom, scientists have been interested in knowing the structure of nuclei, and of the forces which hold the nuclear particles together. The nucleus is a small entity of the order of 10^{-12} to 10^{-13} cm, and as such it cannot be seen even under the most powerful microscope. To "look into" the nucleus one has to think of some indirect methods. The one which seemed the most appropriate was somehow to "break" the nucleus into fragments, and to speculate about it from the nature and the directions of its outgoing components.

In 1919, Ernest Rutherford (U.K.) reported the first successful disintegration of a nitrogen nucleus with naturally occurring alpha particles (nuclei of helium atoms) of 5 to 8 MeV energy (1 MeV$=$1.6 x 10^{-6} erg) from thorium. The energies of these naturally occurring alphas were far in excess of the energies available otherwise in the laboratory. To perform disintegration experiments efficiently and in a controlled manner, physicists for the first time realised the need for artificial sources of high-energy particles. These sources, now called the particle accelerators, are machines for producing high-speed particles. The energy of a particle of mass m accelerated to a velocity v (low, compared to the velocity of light) is given by $\frac{1}{2}mv^2$. Particles accelerated by these machines are used as projectiles to bombard the nuclei targets.

Today accelerators are an indispensable tool of nuclear research. Their installation and running costs are enormously high. Some, like the linear accelerators, are so big that they are kilometers long.

Invention

The development of particle accelerators began in late 1920s. The first invented by J. D. Cockcroft and E.T.S. Walton at the Cavendish Laboratory, Cambridge, was an electrostatic accelerator in which charged particles were accelerated by a strong electric field. In 1932 this machine was the first to "split" a lithium

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nucleus with artificially accelerated protons of about 400 keV energy (1 keV=10^{-3} MeV). The velocity of a proton (hydrogen ion) of 1 MeV energy is 14 million m/sec.

As electrostatic accelerators suffered from the defect of insulation breakdown at high voltages, machines which could accelerate particles in numerous small steps of low voltages were needed. One such machine, called the cyclotron (earlier named the magnetic resonance accelerator), was conceived in 1929 by Ernest O. Lawrence at the University of California, Berkeley (U.S.A.). In 1932 this machine was used by Lawrence and M. Stanley Livingston to disintegrate a nucleus with protons of 1.2 MeV, the highest energy then available in the laboratory. Lawrence was awarded the 1939 Nobel Prize in Physics for the invention of cyclotron.

Cyclotrons, which later formed the basis of a whole series of cyclic accelerators, were developed at a tremendous speed, their size growing bigger with the increasing need of more high energy particles. Their number in the world is now well over a few hundred. It is only in the last decade or so that their use in other branches of physics and science has been extensively explored.

Principle

A cyclotron consists of two hollow semi-circular metallic boxes D_1 and D_2 (Fig. 1), usually called the "dees" because of their shape. These dees are placed in an evacuated chamber C which is fixed within the pole faces of an electromagnet. The magnetic field, which acts perpendicular to the plane of the dees is uniform in the centre, but decreases slightly as one moves away from it. The dees are connected to a high frequency oscillator to provide them with a high frequency alternating potential. The dees then act as electrodes. When one dee is positive, the other becomes negative, and vice versa.

Positive ions are produced in the ion source S placed near the midpoint of the gap between the dees. If at the time of formation of a particular ion the dee D_1 is negative, the ion gets accelerated towards it. Once inside D_1, it moves in a circular path under the influence of the magnetic field quite unaffected by the electric field. If at the time of its exit from D_1 the oscillator reverses the polarity of D_2 making it negative, the ion again gets accelerated in going from D_1 to D_2. As a result the ion gains kinetic energy, which increases its speed. It then

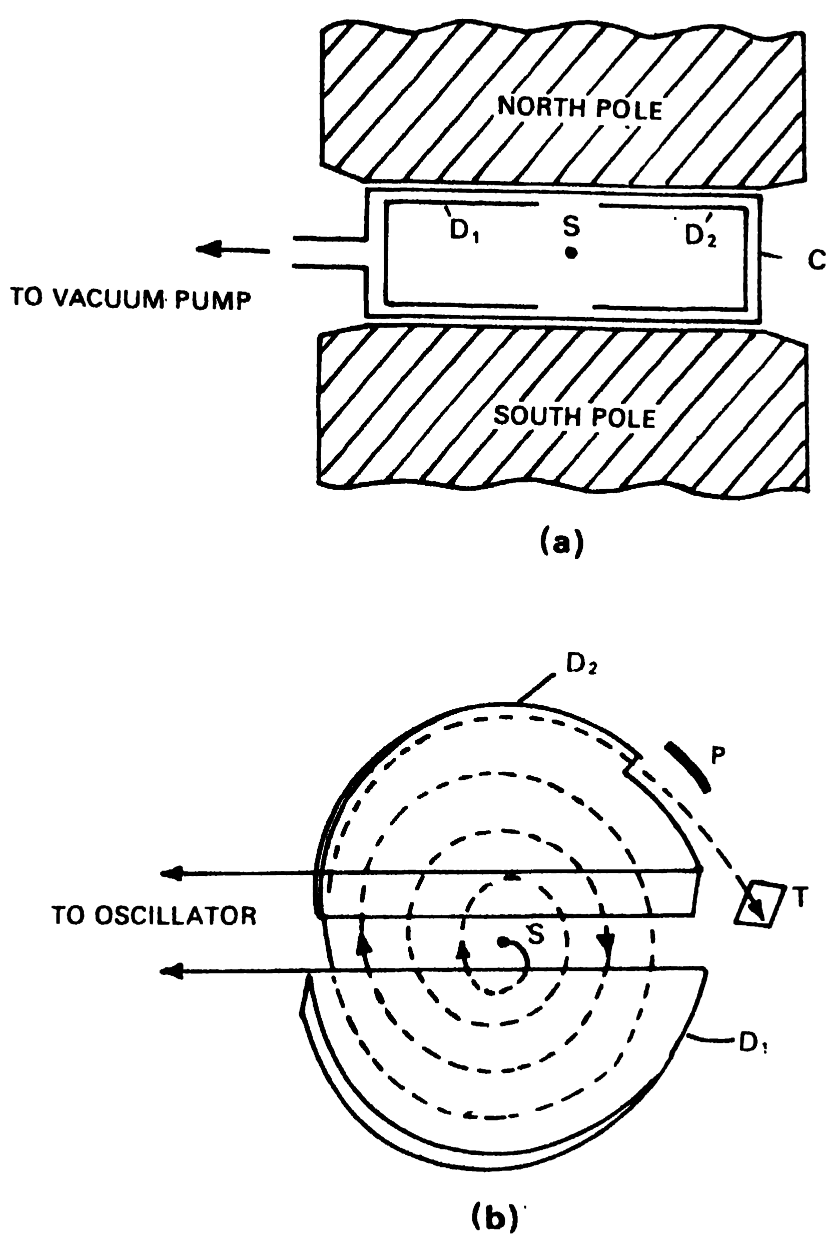


Fig. 1. Principle of cyclotron: (a) vertical view of the main part of the machine, (b) path of the particle within the dees

moves in a circle of greater radius in D_2. On exit from D_1, it again gets accelerated if D_1 by then becomes negative. This process continues till the ion reaches the periphery of the dees where it is pulled out by applying a strong negative potential to the deflecting plate P, and is made to bombard the target at T. In short, the magnetic field simply "guides" the ion to follow a circular path, while the electric field gives it small "pushes" at regular intervals to increase its speed. This makes the ion path a spiral of increasing radius.

The "beauty" of a cyclotron is that at speeds lower than the velocity of light the angular velocity of the ions remains constant; that is, the slower ions move in circles of smaller radii while the faster ones in those of bigger radii. This forces all the ions to return to the gap (between the Ds) at the same time irrespective of their speeds. The ions always gain energy in the gap provided the oscillator frequency is such that it takes the same time in reversing the polarities of the dees as is taken by the ions in traversing the semi-circles. The final energy of the ion is equal to that gained in one passage through the gap multiplied by the number of such traversals.

The energy acquired by the particles in a cyclotron is independent of the dee voltage. When voltage is small, the particles make large number of turns before reaching the periphery ; when voltage is high, the number of turns is small.

Only charged particles like protons, deuterons, alphas, ions of light and heavy elements can be accelerated in a cyclotron, as an electric field can exert force only on the charged particles.

The diameter of the magnetic pole faces is often used as a measure of the size of a cyclotron. Many times only one dee, instead of two dees, is used in a cyclotron.

Energy limit

The energies to which the various particles can be accelerated in a cyclotron are limited by two factors: (a) by the decreasing magnetic field near the periphery of the pole faces, necessary for focussing (keeping particles on their path in the horizontal plane); and (b) by the relativistic increase in mass of the particles at high velocities (near the velocity of light). Because of both of these, the angular velocity of the ions becomes low near the periphery of the magnetic pole faces and they start getting "out of step" with the frequency of the alternating voltage. As a result, the ions are not further accelerated.

Ordinarily, a cyclotron can accelerate particles to velocities upto about $0.2c$, where c is the velocity of light. The relativistic increase in mass at this velocity is about 2 per cent. This limits the size of the cyclotron and the energies to which the various particles can be accelerated. The limit for accelerating protons is about 25 MeV. Deuterons and the alpha particles can be accelerated to still higher energies.

Modifications

For many nuclear experiments we need particles of a few tens of MeV of energy So sometimes the attainable particle energies from an ordinary cyclotron pose a serious limitation. To push up these energies two different techniques have been devised. They depend on compensating for the decrease in angular velocity of the particles at high speeds (near the periphery of the dees). In the first technique, the frequency of the accelerating voltage is continuously decreased from some maximum to a minimum value, as the particles move away from the centre of the machine. In the second, the intensity of the magnetic field is continuously increased from the centre towards the periphery of the magnetic pole faces (keeping a fixed frequency for the accelerating voltage). With the increasing magnetic field, the particles feel stronger bending forces and move in circles of smaller radii. The shortened paths compensate for the decreased angular velocity at high speeds.

The cyclotrons based on the first modification are called the synchro-cyclotrons or the frequency modulated (FM) cyclotrons. These machines do not produce particles in a continuous stream, but in small 'bursts". Energies of about 750 MeV for protons have been obtained using these machines. The FM cyclotrons are usually used in high-energy (elementary particle physics) research.

In connection with the second modification, it was observed by H. A. Bethe and M. E. Rose of U.S.A. that a field which increases as we move away from the centre of the machine has a defocussing action in the vertical direction and so cannot be used in an accelerator. Because of the vertical defocussing, the particles move up or down and get lost in the walls of the dees. In 1938 L. H. Thomas (U.S.A.) suggested a way out. Incidentally, however, his suggestion was not put to test for over a decade due to the development of synchro-cyclotrons. The first two small model machines based on Thomas's idea were constructed at Berkeley in 1952. But the real interest was taken in these machines only after 1955 when E.O. Lawrence reported about them at the "Atoms for peace" conference in Geneva.

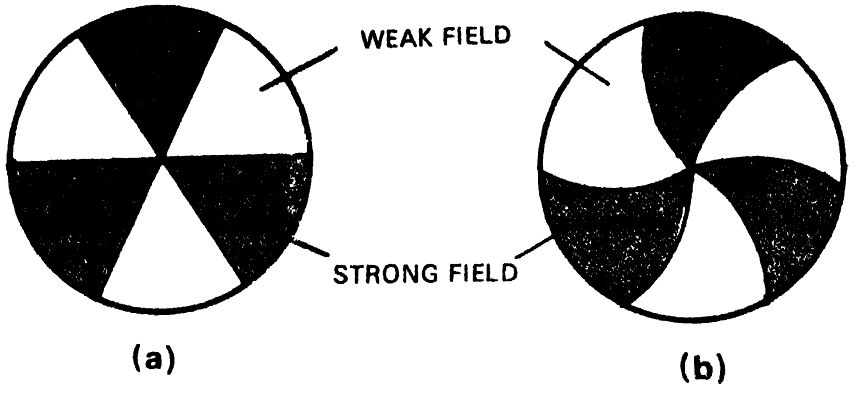


Fig. 2. Pole faces of sector-focussed cyclotron. Shaded areas represent ridges or "hills" while unshaded areas represent empty spaces or "valleys"; (a) radial ridges, (b) spiral ridges

In machines based on Thomas's idea, the magnetic pole faces are not flat but fastened with iron slabs either in the radial direction or spiraling outward in gentle curves (Fig. 2). These slabs, called sectors or ridges, have gaps of empty space in between of about the same size. As the pole gap between the ridges is small, the magnetic field is stronger there compared to the one in the "valley" regions. This gives alternating regions of strong and weak magnetic fields. The magnetic field depends on both: the radius as well as the azimuthal angle. Such a field provides strong focussing of particles, particularly if spiraling sectors are used. The path of the particle in these machines is only nearly circular, with pronounced curvature in the "hill" regions than in the valleys (Fig. 3).

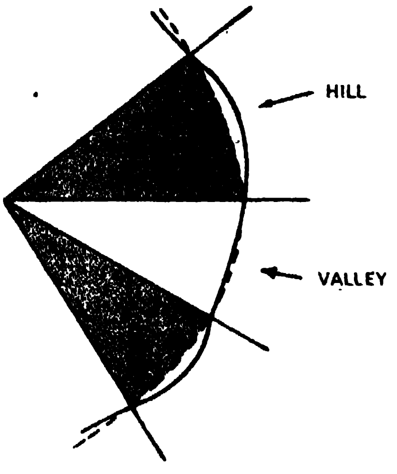


Fig. 3. Trajectory of a particle in an isochronous cyclotron. Circular path, for reference, is shown by a shaded line

The machines based on the above design are called the sector-focussed cyclotrons or the isochronous-cyclotrons. They are also sometimes referred to as the azimuthally varying field (AVF) cyclotrons. Energies of about 580 MeV for protons have been obtained using these machines.

Most of the present day cyclotrons operate over wide range of oscillator frequency and can, therefore, accelerate particles to a desired range of energies (of course, upto a maximum possible from the machine in question). These cyclotrons are then also called the variable energy cyclotrons (VEC). In them, the strength of the magnetic field is also varied to make the particles return to the gap "in step" with the frequency of the oscillator.

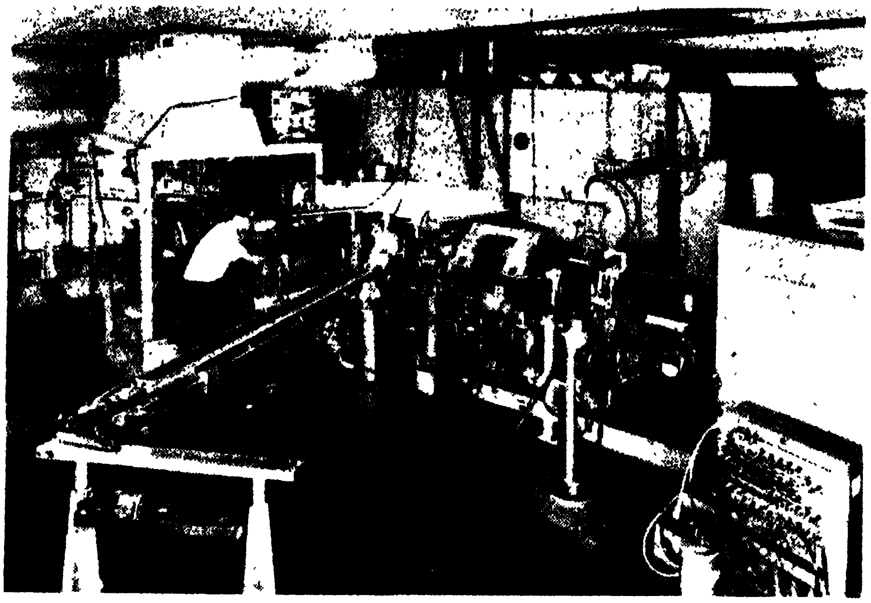
The increase in magnetic field from the centre to the periphery of the magnet in an AVF cyclotron is often achieved by the use of some pairs of concentric circular coils, usually called the "trim" coils. These coils are placed on the upper and the lower pole faces of the electromagnet. By passing suitable current through these coils appropriate increase in magnetic field with radius may be obtained.

Particle beams from cyclotrons are usually of good intensity but of large variation in energy. However, by magnetically analysing the beam before bombardment, this energy variation may be decreased even to about 5 keV. Usually cyclotrons are best suited for intermediate energy (> 5 MeV) experiments; for low-energy work electrostatic accelerators are preferred. To decrease the output energy from cyclotrons, sometimes metallic foils are inserted in the path of the beam before the bombardment.

Nuclear studies

Cyclotron is a very powerful and versatile tool for nuclear research. Quite a substantial part of our presentday knowledge about the nucleus has been gained by the use of these machines. Their importance in nuclear research may be judged from the following: Cyclotrons were the first to artificially produce in 1936 a naturally occurring radionuclide radium E; to discover in 1938 an artificial element technetium; to produce in 1940 a transuranic element (with proton number, Z, greater than 92); to discover the mass 3 isotopes of hydrogen and helium, etc.

An interesting field which is now opening up is that of superheavy elements. For long, theoretical physicists have speculated about the possible existence of some very heavy elements (heavier than even the transuranic elements). It was thought that after a region of very great instability, $106 < Z < 112$, due



The 88 inch spiral-ridge sector-focussed cyclotron at Berkeley. Experimental area with the necessary equipment is shown in the foreground. (*Courtesy*: Lawrence Radiation Laboratory, University of California)

to low fission barriers, an island of stability connected with the magic numbers may be observed. Recently, some U.S. scientists, R. V. Gentry, T. A. Cahill and others, have obtained the first experimental evidence for the existence of three superheavy elements with $Z \neq 116$, 124 and 126. Cyclotrons, in combination with other accelerators, may be used to produce artificially these elements, and to look for some new ones.

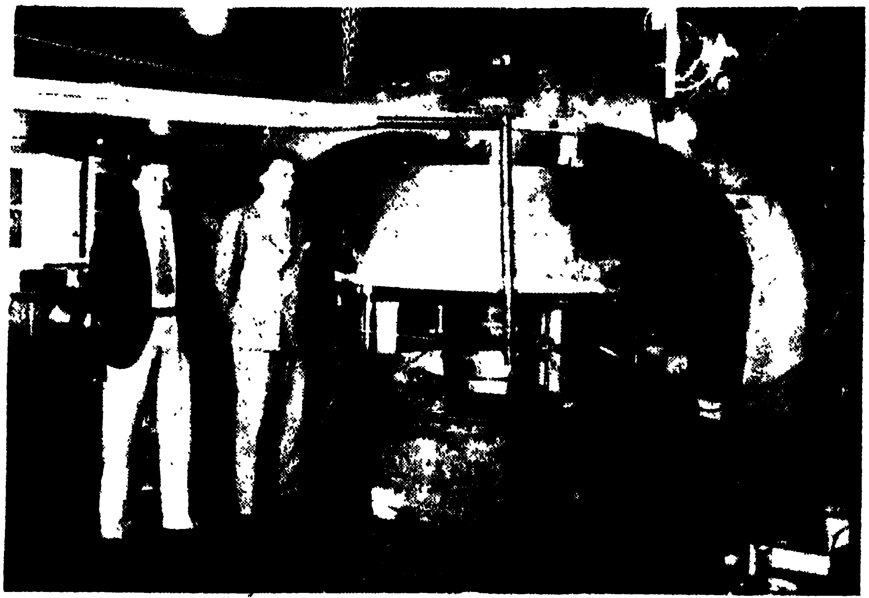
Other applications

Apart from the use of cyclotrons in nuclear research, these machines are now also being extensively used in many different branches of physics and science. Many of their applications are in fundamental fields with tremendous potential for gaining new knowledge and in applied fields with vast uses in industry. Their use in medical science is on the rise.

One of the most important applications of cyclotrons is in the production of radio-isotopes. These isotopes have numerous uses in almost all branches of science. Their contribution in the therapy of some lethal diseases like cancer, and as "tracers" in biology and agriculture are too well-known. As isotope producers cyclotrons have always been of great value. They can even produce those isotopes which cannot be obtained using a nuclear reactor. For producing very short-lived clinically useful radio-isotopes, cyclotrons have even been installed in some medical centres in advanced countries.

Cyclotrons are used for therapeutic work also by directly exposing the patients to well-defined beams of neutrons. A recent advancement in medical science using particle accelerators is in meson therapy. In an experiment at Los Alamos (U.S.A.), pions (π-mesons) have been used to cure deadly skin tumours. The cure with pions has been found to be definitely better than with the X-rays. At present only five cyclotron meson facilities exist, the notable among them are the TRIUMF (Canada) and the SIN (Switzerland).

Neutron beams from cyclotrons may be used for non-destructive testing of heavy and complicated parts of machinery (neutron radiography). Damage caused in various structural materials by high-energetic particles (radiation damage) may also be studied. An important use of radiation damage studies is in nuclear technology. Nuclear reactor materials usually get damaged because of heavy bombardments by fast neutrons from the reactor core. Another use of cyclotrons is in determining



The 27 inch cyclotron built at Berkeley in 1934 (*Courtesy*: Lawrence Radiation Laboratory, University of California) the elemental and/or isotopic composition of material samples (materials analysis).

Trends and prospects

There are now about 20 AVF cyclotrons in the world with proton energies greater than 45 MeV. General trend these days is in building cyclotrons with still higher energies and developing heavy-ion sources for possible use in these machines. A challenge for cyclotron experts is to design small, reliable, cheap and easily operable machines which can be installed in hospitals for medical applications. Nowadays, instead of installing a cyclotron in a hospital, one may have to think of building a "hospital near a cyclotron."

A recent improvement over the existing cyclotrons is the "superconducting cyclotron." In this cyclotron, one can reduce the amount of iron needed for the magnet by the use of superconducting magnetic coils. This is expected to reduce the conventional cost of cyclotrons to about half. The two superconducting cyclotrons under construction are at the Michigan State University (U.S.A.) and at the Chalk River Nuclear Laboratories (Canada). Design studies for such a machine are also underway at the Lawrence Radiation Laboratory, Berkeley.

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Cyclotrons in India

A variable energy cyclotron is being installed at Calcutta at a project cost of Rs. 8 crores by the Bhabha Atomic Research Centre, Trombay. When operational, it is designed to produce 6-60 MeV protons, 12-65 deuterons and 25-130 MeV alpha particles. It is a three sectored (spiral) AVF cyclotron, whose design has been adapted from a similar machine at the Lawrence Radiation Laboratory, Berkeley, (U.S.A.). Some of its design specifications are :

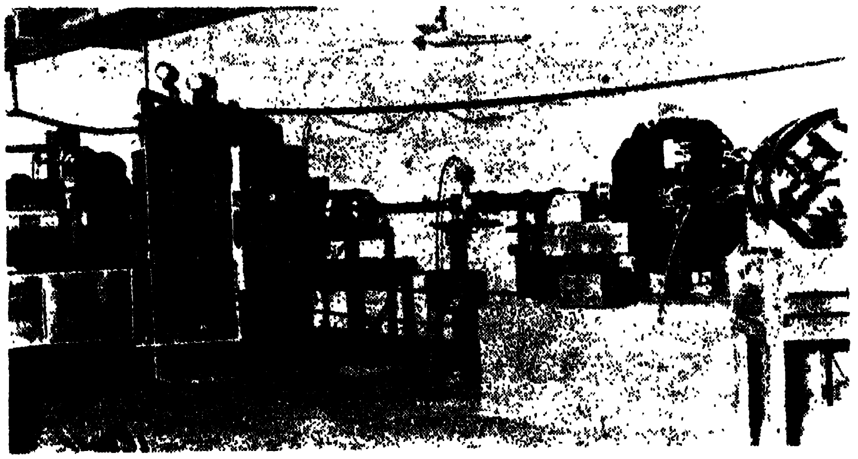
Weight of the magnet	262 tons
Diameter of pole faces	224 cm
Average magnetic field	17 kilo gauss
Pole gap between ridges	19 cm
Pole gap between valleys	30 cm
Trim coils	17 pairs
Oscillator frequency range	5.5-16.5 mega hertz
Maximum dee voltage	70 kilo volt
Maximum deflector voltage	120 kilo volt
External beam	100 micro ampere
Main coil power	490 kilo watt

Various components of this machine have been fabricated in different institutions in India. Main participants in this commendable feat of collaboration are the Heavy Engineering Corporation, Ranchi, Heavy Electricals, Bhopal, Garden Reach Workshop, Calcutta, and the Bhabha Atomic Research Centre, Trombay. This machine will be a national facility for advanced research in nuclear physics and for the controlled direct irradiation of biological and agricultural products.

The other cyclotron, a small "conventional" machine, has started functioning recently at Panjab University, Chandigarh. This machine, a gift from the University of Rochester (U.S.A.), is designed to accelerate 2-8 MeV protons, 1-4 MeV deuterons, 2-8 MeV alpha particles and 3-11 MeV ^{3}He nuclei. Some of its design specifications are :

Weight of the magnet	20 tons
Diameter of pole faces	26 inch
Maximum magnetic field	14 kilo gauss
Dee voltage	30-40 kilo volt
Oscillator frequency	10-20 mega hertz

Both the Calcutta and the Chandigarh cyclotrons are single dee machines. A small cyclotron is also at Saha Institute for Nuclear Research, Calcutta.

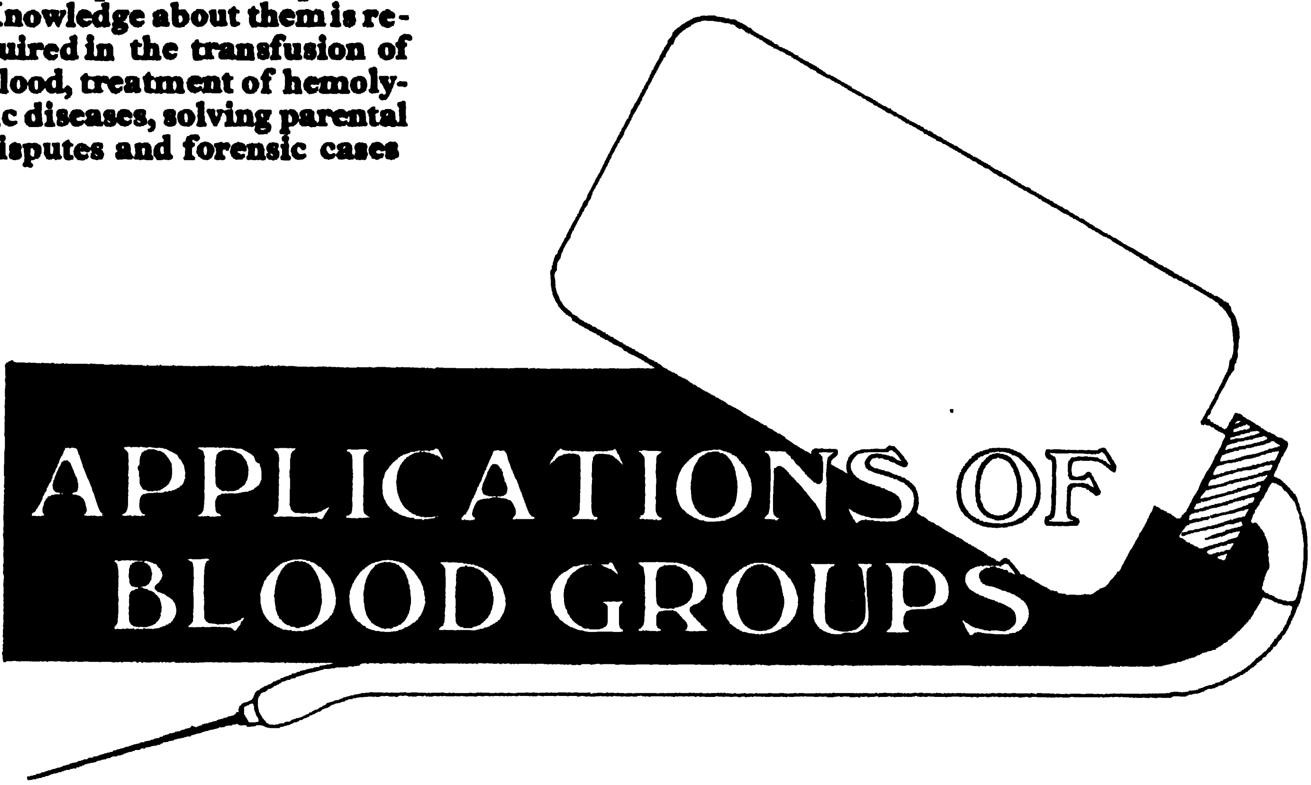


A part of the cyclotron machine at Panjab University Chandigarh (*Courtesy*: **Professor H. S. Hans**)

Antigens and antibodies, the blood group factors, vary from person to person. Knowledge about them is required in the transfusion of blood, treatment of hemolytic diseases, solving parental disputes and forensic cases

D. P. BHATNAGAR

APPLICATIONS OF BLOOD GROUPS



BLOOD consists of plasma and cells. It is primarily a medium for the carriage of oxygen, nutrients, hormones and antiinfection agents to the tissues and for the removal of carbon dioxide and other waste products from the tissues and their elimination from the body. Antibodies belong to γ-globulins and are formed widely in the body by reticulo-endothelial system. The antigen is found on the red blood cells.

Blood group factors belong to the family of substances known as antigens and antibodies. A type of serological reaction between antigens and antibodies which results in the clumping of red cells is known as agglutination. Antigens and antibodies vary from person to person. These differences in human blood are the basis of blood groups. Table 1 shows most of the human blood group systems and some of the related antigens within each system.

The knowledge of blood groups can be applied in the following fields.

Blood transfusion

From early historical times, the use of blood as a therapeutic measure was advocated, some people believed that the blood not only carried the vital force of the body but was also the sea for soul. During the Middle Ages the drinking of blood was much recommended for rejuvenation and treatment of various diseases. Hieronymus Cardanus (1505-1576) and Magnus Pegelius suggested the possibilities of tansferring blood directly from the blood vessels of one individual to another. In 1667, Denys and Emmerez transfused the blood from the carotid artery of a lamb into the vein of a youngman. This transfusion was successful. A patient in France died when Denys tranfused blood because the patient received fatal transfusion. The fatal results from transfusion led to the discovery of blood groups. With the knowledge of blood groups, the process of blood transfusion is carried out safely.

Hemolytic disease

Blood groups play a significant role in the hemolytic disease of the newborn. When an Rh-negative mother carries an Rh-positive foetus, some of the foetus antigens pass through placental barrier and stimulate the production of Rh antibodies in the mother's blood. When these immune antibodies enter foetus circulation,

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Table 1

System	Antigens
A_1A_2BO	A_1, B, H, A_2, A_3, A_x
Rh	D, C, c, C^w, C^x, E, e, e^s, E^w, G, ce, ce^s, Ce, CE, D^u, C^u, E^u
MNSs	M, N, S, s, M_2, N_2, M^c, Mi^a, Vw, Mu, Hu, M^g, Vr, M_1, Mt^a, Ri^a, St^a
P	P_1, P_2, P^k
Lutheran	Lu^a, Lu^b
Kell	K, k, Kp^a, Kp^b, Js^a, Js^b
Lewis	Le^a, Le^b
Duffy	Fya, Fyb
Kidd	Jk^a,Jk^b
Diego	Di^a
I	I, i
Aubergar	Aua
Xg	Xg^a
Very infrequent antigens	Levay, Becker, Ven, Wr^a, Be^a, Rm, Sw^a, Good, Bi, Tr^a, Wb .
Very frequent antigens	Vel, Yt^a, Ge, Lan, Sm

they destroy the red cells of foetus and cause hemolytic disease of newborn or erythroblastosis foetalis. The detection of immune antibodies in the maternal circulation in early pregnancy can save the foetus by various methods like early delivery and exchange transfusion (Jolly *et al.*, 1970; Bhatnagar, 1972 and Sidhu and Bhatnagar, 1974).

Parentage disputes

Blood groups can be applied in medico-legal cases of disputed parentage, where problems of determining blood relationship arise. The problems may be :

(a) a husband denies paternity of a child, (b) man named by the mother as the father of a child denies paternity, (c) two newborn infants have been accidentally interchanged in a hospital shortly after birth and it is desired to identify the parents of the infants, (d) it is suspected that a wet nurse has wilfully substituted her own infant for the one placed in her custody, so that her own child may have the benefits of a better home, and (e) a woman has simulated pregnancy and child birth and now pretends that the child is her own in order to compel a man to marry her or to obtain dowry of her dead husband's estate or be heir to her husband's estate.

For this purpose ABO and MN systems of blood grouping are most commonly employed. Table 2 shows the possibilities of children's blood groups in various parental blood groups combinations.

Forensic cases

Blood grouping has proved to be of great value in criminal or forensic cases where it is required to determine the origin of blood stains. This application was first suggested by Landsteiner and Richter who showed that it is possible to demonstrate the presence of antibodies in dried blood stains. Blood grouping tests on blood stain were first applied in criminal cases by Latters in 1916 in an Italian criminal court. Blood grouping tests may help not only to acquit the innocent but also convict the guilty. The properties of antigens A and B can be demonstrated in the seminal fluid. This may prove helpful in the cases of rape or assault.

Table 2

Blood groups of parents	Blood groups of children	Blood groups of children not possible
O×O	O	A, B, AB
O×A	O, A	B, AB
O×B	O, B	A, AB
A×A	O, A	B, AB
A×B	O, A, B, AB	—
B×B	O, B	A, AB
O×AB	A, B	O, AB
A×AB	A, B, AB	O
B×AB	A, B, AB	O
AB×AB	A, B, AB	O
M×M	M	N, MN
N×N	N	M, MN
M×N	MN	M, N
MN×M	M, MN	N
MN×N	N, MN	M
MN×MN	M, N, MN	—

Genetics

The discovery of so many human blood groups is providing a new tool for studying the Mendelian inheritance. The geneticists have long felt that the blood groups are an ideal material for the study of human genetics. They are easily determinable inherited characters unaffected by environment. So what more could a geneticist desire ? Blood groups can be used in the study of human genetics as under :

(a) to study each blood system, not only as examples of straight Mendelian inheritance but also the effect of one gene on another, position and dosage effects and closely linked genes ; (b) use of blood groups as markers of chromosomes; (c) in balanced polymorphism. It follows that natural selection is influenced by our blood groups differences. Different combinations of genotypes will have slightly different survival values; and, (d) relation of blood groups with diseases.

Anthropology

All the known blood group systems how variations in gene freque, ncy in different popμlations. The first published discovery that frequency of the blood groups varied from one population to another was made by Professor and Mrs. Hirszfeld, when they were working at Salonika during the First World War. Now, at present, the distribution of various blood groups is fairly well-known. It has been concluded that the population has reached an equilibrium—the proportion of blood groups remain constant from generation to generation, provided there is no crossing with other people. Verzar and Weszechoky studied the distribution of blood groups in gypsies, who had originally lived in India and then migrated to Hungary where they lived for several hundred years. It can be seen that the serological composition of gypsies does not differ from the natives of India, although it differs greatly from the Hungarians among whom they live. Similar results were obtained by them when they studied the distribution of blood groups among German colonies in Hungary. Aggarwal (1966) worked on Burmese immigrants. Knowledge of blood group gene frequencies in the population helps in setting up of blood banks, immunization units and ante-natal clinics accordingly.

Archaeology

Blood groups are also applicable to the comparative study of genetic composition of the population who lived in the last few thousand years from now. It was believed that blood groups of the people of the past could not be determined, for all that ever remains of them is skeletons or bloodless mummies, but even these dry relics may be made to reveal their blood groups. The chemical substances of blood groups are not restricted to the red cells of the individuals, but exist throughout his body in practically all his cells and tissue fluids. They are rather unusally stable antigens. They resist drying, heating and exposure to a number of drastic chemical reagents which would quickly inactivate the protein antigens. The study of Egyptian mummies revealed that the frequency of antigen A and B was not as high as in their present day descendants. In American Indian mummies of Wild West United States, the antigen A was very infrequent and only one B group individual was reported from all the specimens studied. The present day Indians of that region show patchy frequency of A, and group B is perhaps entirely lacking. Blood groups offer most valuable information on the origin of races.

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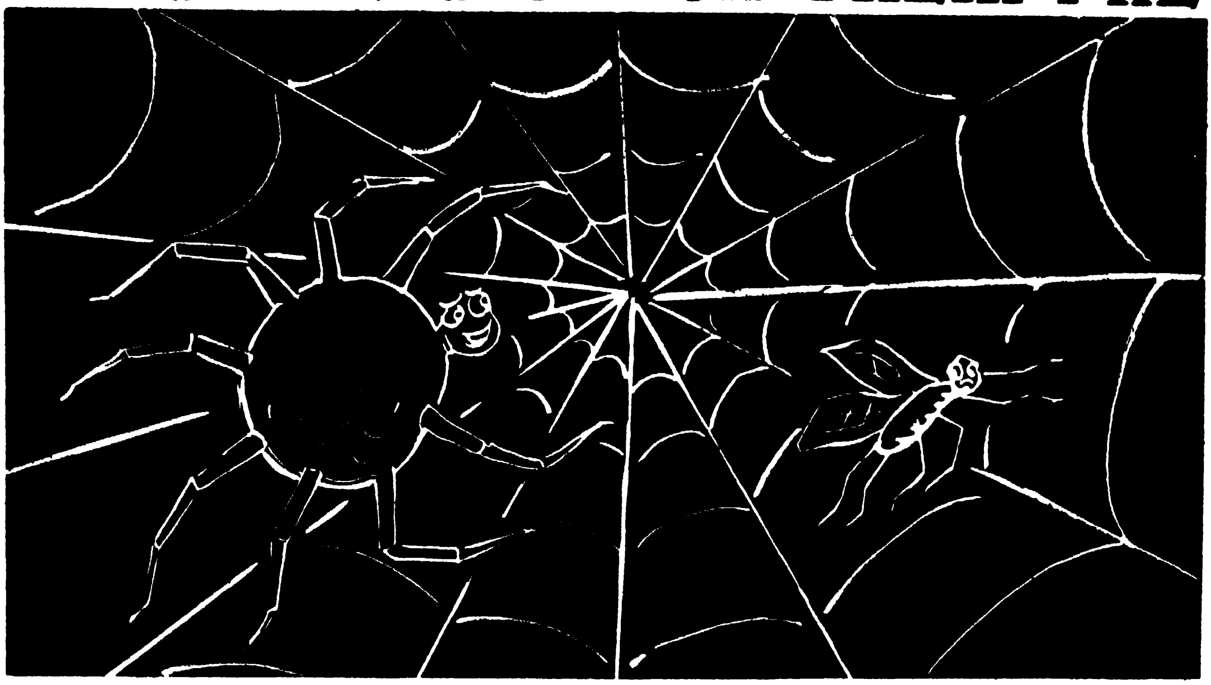
HOW SPIDERS CATCH THEIR PREY



B.L. BRADOO

Spiders use a variety of devices to catch their preys

SPIDERS are well-known predacious representatives of the phylum Arthropoda. They obtain their prey by several methods depending on the type of the species. The jumping spiders of the family *Salticidae* and the wolf spiders of the family *Lycosidae* do not spin any capture web. Instead, they wander in search of a suitable prey and pounce upon it. The crab spiders of the family *Thomisidae* wait and hide in flowers to capture insects that visit them in search of nectar and pollen (*S.R.*, Aug., 1973). The commensal spiders of the genus Argyrodes (Fam: *Theridiidae*) are small individuals that live on the web of some other large spiders and feed upon the smaller entrapped insects that have been neglected by the host spider. The parasitic spiders, however, steal and feed on useful preys that are entrapped in the host web (Kullmann, E., 1960, *Verh. Deut. Zool. Ges.*, 332-342).

The web-building spiders make various types of silken snares for catching their preys. Such webs (snares) differ much in shape and structure. Some spiders spin only an irregular net, but the species of Linyphia make sheet webs and the common grass spider, Agelana, makes a funnel web.

The circular webs, also called orb webs, are common in lawns and inside homes made by the species of the family *Argiopidae* and *Uloboridae*. The various stages in the construction of an orb web and the chemical nature of the spider silk are described in *Science Reporter* (Aug. 1973). The structure of an orb web is shown in (Fig. 6). It consists of a frame of supporting silk threads from which arise many radii (20-40) that converge at the central close meshed disc of silk called, hub. The hub serves as the resting platform for the spider while he keeps watch for the possible insects that may fall in the completed web. After the hub is complete, the spider makes temporary spirals over the radii for going from one radius to the next, for future spinning activity. After this, the spider spins sticky spiral threads arranged in circles, starting from the periphery of the orb till it reaches close to the hub, leaving a little gap in between the two. The spiral sticky threads are directly produced from the spinnerets as the spider moves from radius to radius

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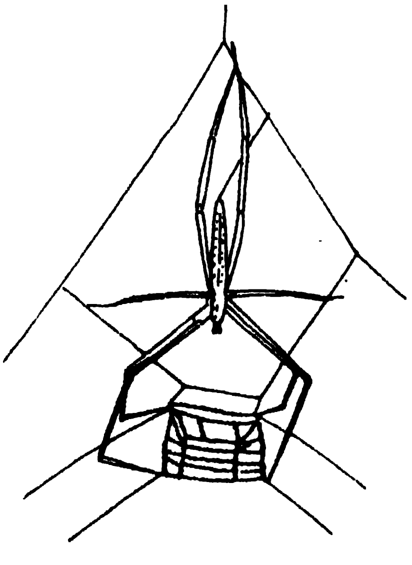


Fig. 1

(e.g, *in Argiopidae*). But the species of the family *Uloboridae* produce the spiral sticky thread as a secretion of the special silk glands called cribellar glands. The cribellar silk is elastic and adhesive. It is brushed out of a special porous plate called cribellum (Fig. 8) (located on the ventral side of the abdomen in front of the spinnerets) with a special brush of hairs called calamistrum located on the hind legs that are used during spinning of cribellar silk (hackled band silk).

When a suitable prey falls in any of the types of the web mentioned above, the spider covers the victim in a sheet of silk produced from the spinnerets. Then digestive enzymes are poured over the prey to digest its soft parts that are eventually sucked by the spider (extracellular digestion). The remains of the prey are added to the nest structure or may be thrown down by the spider.

Many spiders have devised some unusual and unique methods of prey capture, showing many variations in feeding behaviour which help them to remain alive in extreme and unfavourable conditions. These adaptations provide them with greater chances of evolution and natural selection. They can even live without any food and water for a long time, if forced to do so.

Unusual feeding methods

Hurling webs (fishing nets). Spiders that make various types of web wait for preys that come and strike their webs. But the species of the family *Dinopidae* which includes two important genera, Dinopis and Menneus, catch small insects by hurling their sticky webs with the help of their long thin legs. The American stick spider, *Dinopis spinosus*, from Florida, spins a small rectangular web across which are laid a number of sticky cribellar silk threads. The completed web is held with the first two pairs of legs (Fig. 1) stretched 5 to 10 times its original size and then hurled over a passing insect. The prey captured in this manner is then wrapped in silk and bitten before the feeding starts.

This unique method of prey capture has been confirmed by M.H. Robinson and Barbara Robinson (1971) in *Dinopis longipes*, a specialist in capturing ants, found in Panama.

Spring webs. The ray-spider, *Theridiosoma radiosa*, spins a unique orb web without a central hub. The radii converge upon a small number of lines radiating from a point near the centre. The sticky spiral turns are less than 12 in number. The spider rests in the centre of the web and pulls the orb into the shape of a cone (funnel) (Fig. 7). When an insect gets entangled in the web, the spider releases its hold, allowing the web to spring back that ensnares the prey more firmly.

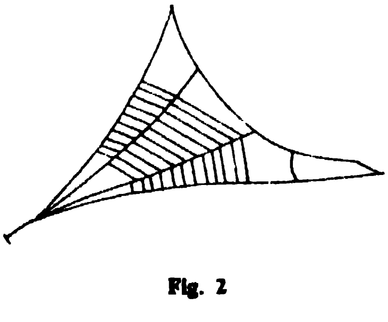
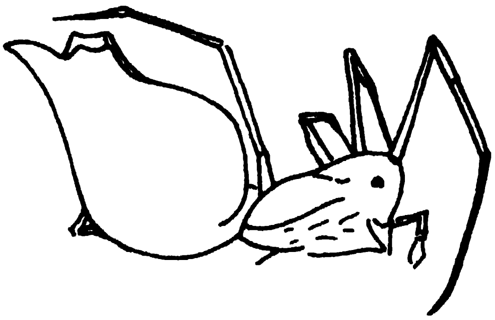
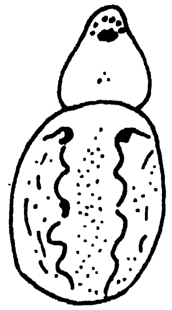


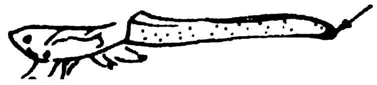
Fig. 2



ARGYRODES



THERIDION



MIAGRAMMOPES

Some Indian spiders.

Spiders of the genus Hyptiotes (*Uloboridae*) construct a vertical triangular web (Fig. 2) that has only 4 radii of non-sticky silk. About 10 to 20 sticky silk threads are then laid on these four radii that meet into a single draw thread fixed to a nearby twig. The spider then cuts the draw thread and suspends itself between two parts of the draw thread. It holds the anterior thread taut with its legs. When an insect strikes the web, tension is released at once so that the prey is entangled and captured by the spider.

The African stick spider, *Miagrammopes*, spins a single silk thread, about one meter long, between any two adjacent twigs. The central part of the thread is covered with sticky cribellar silk and then the spider holds its one end taut like *Hyptiotes* does. When a small insect alights on the web, tension is released that entangles the prey. In 1971, Dr. B.K. Tikader described five new species of this interesting genus in India.

Professor B. J. Marples of New Zealand reported in 1955 another single line web (10 cm long) in *Ulesanis pukeiwa*. This spider rests on a twig and holds the silk thread, coated with droplets of sticky silk, in tension. The thread entangles a suitable prey when made slack by the spider.

Gum-footed webs. Some spiders like *Steatoda*, *Teutana*, *Theridion lunatum*, *T. saxatile*, *Lithyphantes albomaculatus* and sometimes the common house spider *Theridion tepidariorum* make special gum-footed webs. These webs consist of a number of straight vertical threads attached to the substratum which bear at the lower end (for about 3mm) a coating of 3 to 10 visced globules of silk for trapping small ground insects.

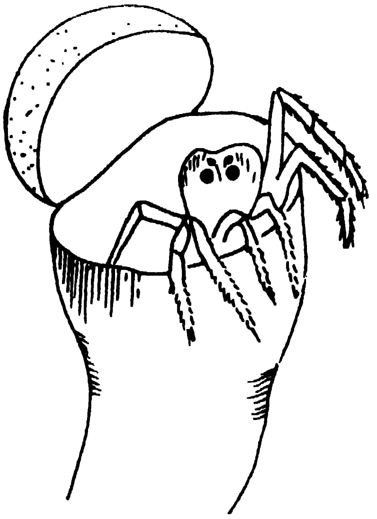


Fig. 3

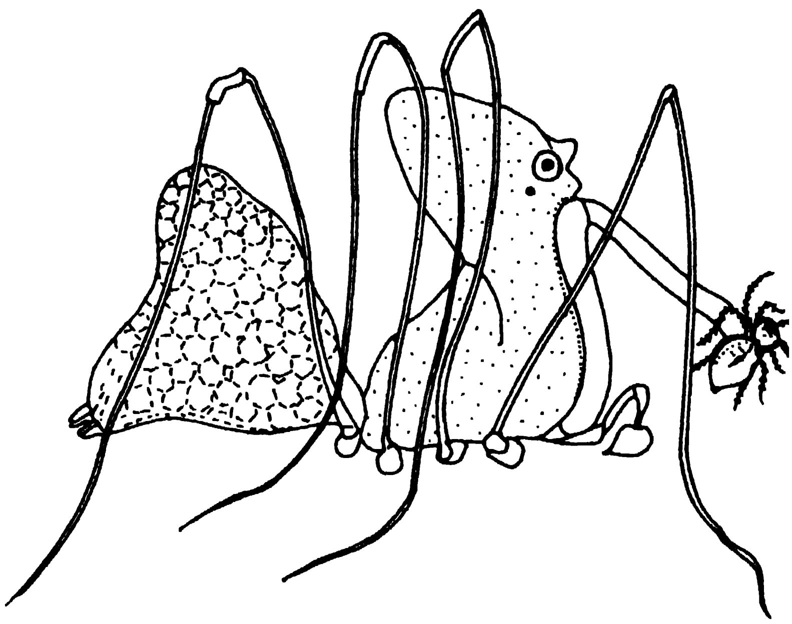


Fig. 4

In case of *Episinus*, the web consists of only two vertical 'gum-footed' threads, connected transversely above, so as to present an H-shaped appearance. The spider hangs from the cross thread with her hind legs and holds her front legs down along the two vertical threads to catch a suitable prey.

Bolas-throwing spiders. The common examples include *Mastophora* from Africa, *Dicrostichus* from Australia and *Cladomelea* from S. Africa. These interesting spiders sit on or suspend themselves from a twig and hold a silk thread. To the lower end of this silk thread is attached a sticky globule of silk which is flung at a passing insect. The insect is then hauled up by the spider. The details of bolas-throwing spiders have been published by C. E. Hutchinson in 1903 (*Scientific American*, **89**: 172) and by Dr. W. J. Gertsch (1855) (*Bull. Amer. Mus. Natur. Hist.*, **106**: 225-254).

Gum-spitting spiders. The spiders of the genus Scytodes catch prey by squirting a mucilaginous secretion as recorded by two workers, S. Dabelow (1958) of Germany and W. H. McAlister (1961) of U.S.A. These spiders raise their anterior legs and search for the prey during night. When a prey is near the spider, the gummy spray is thrown from a distance of about 10 to 20 mm and may be repeatedly thrown. As many as eight sprays have been recorded for one encounter.

Using high speed cinematography, Dr. Dabelow found that the duration of each spray varied from 1/8 sec to 1/6 sec and the gummy secretion was flung at a velocity of 6 to 9 m/sec. In 1930, Professor J. Millot of France studied the anatomy of the glands concerned. He reported that the gland is large with a smaller anterior lobe for venom and a larger posterior lobe that secretes the gum. When the spider bites its prey, only the venom is injected, but when it sprays gum some venom also comes out and paralyses the prey. At least four species of Scytodes have been recorded from India.

Trap-door spiders. The trap door spiders (*Tarantula*) of California and Arizona make simple burrows with the help of their fangs and anterior legs. The burrow (Fig. 3) is lined with silk and has

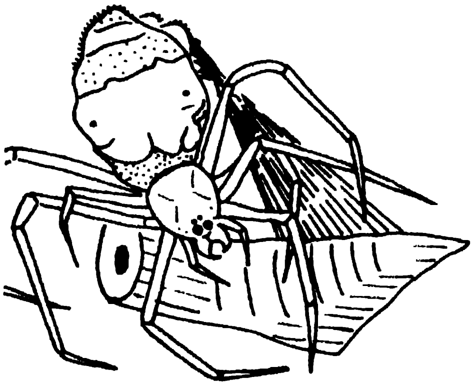


Fig. 5

a heavy door made of alternate layers of silk and earth. The spider takes its position close to an opening beneath the lid (door) that is kept half open for dragging an insect inside the burrow. When an insect is in, the door is shut and the insect is fed upon by the spider. Very often these trap-door spiders camouflage the door with bits of leaves and earth so that the spider is not easily detected by its most common enemy, a large fearless wasp (*Pepsis*) that has a wing span of 7.5 cm to 10 cm.

Spider-eaters (Strict cannibals). The author recorded a green stick-like spider *Ariamnes* sp. (*Theridiidae*) in Kerala (*Ent. Monthly Mag. London*, 1972, **107**:241-243) The adult female spider is about 45 mm long. It spins a straight line-web and suspends itself upside down, holds anterior thread with its front legs and posterior thread fixed with the spinnerets. During the aerial dispersal, when some spiderlings of other species come on the web line, the *Ariamnes* rushes quickly to wrap the prey in silk before actual feeding commences.

W. S. Bristow, a famous arachnologist of England, found that *Ero furcata* paid no attention to various insect preys offered, but it readily accepted other spiders as prey. In 1961, Professor Roland Legendre of Madagascar reported an interesting spider *Archaea* that spins no snare but waits in ambush. When the victim approaches within reach, *Archaea* puts forward one of the very large chelicerae. The prey is impaled on the extended fang (fig. 4) and carried about for a while in this manner before being brought back to be crushed against the legs.

The spiderlings of some species feed on their fellows within the egg sacs. Dr. E. Tretzel of West Germany reported in 1961 that the *Coelotes* spiderlings feed on their mother. This observation was also made by the author in 1972 in social spider, *Stegodyphus sarasinorum*. The young ones of this spider feed on the dead bodies of the old females (mothers) in the nest. In some spiders, the mothers catch suitable preys or regurgitate nutritive secretions for their brood.

Cocoon and egg-eaters. There are records of mother spiders that feed on their own cocoons and

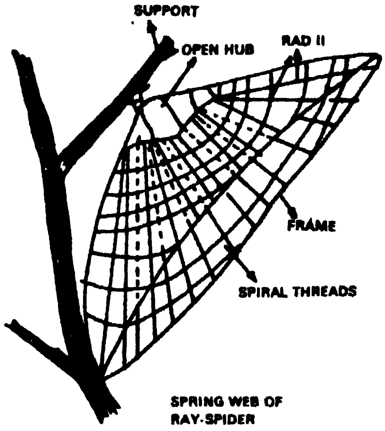


Fig. 7. The spring web of *Theridiosome radiosa* held in the form of a cone by the spider

eggs. Probably such cocoons are defective and eggs infertile. Sometimes, it is the extreme disturbance that forces the mother spider to take such a drastic action as reported in *Scytodes thoracica* (a gum-spitter) by S. Dabelow in 1958 (*Zool. Jahrb.* pp. 85-162).

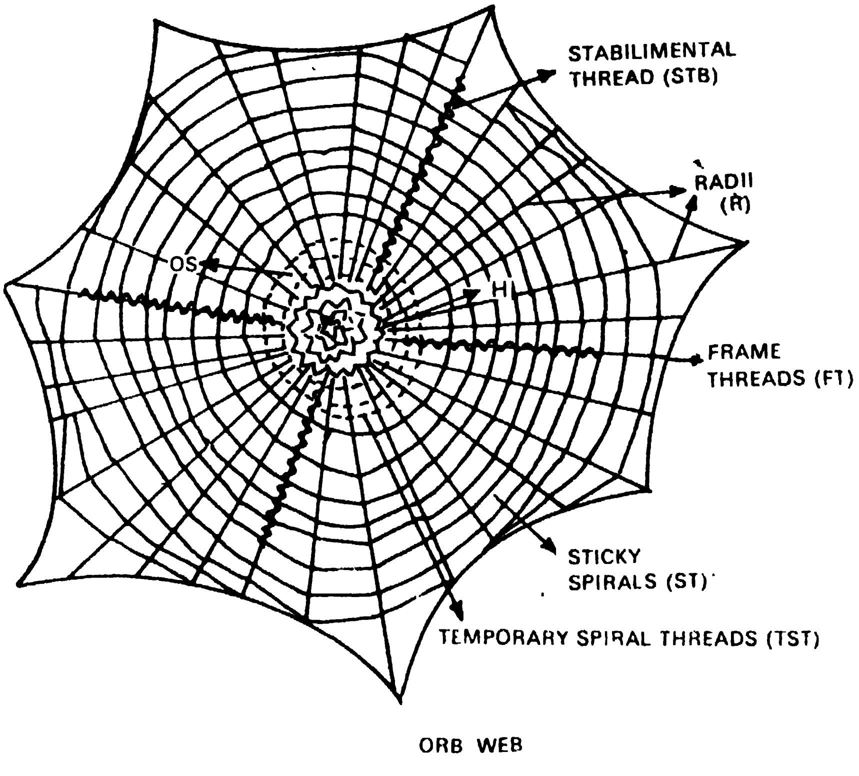


Fig. 6. An orb web showing frame threads (FT), radii (R), hub (H), broken temporary spiral threads (TST), sticky spiral threads (ST) and stabilimental threads (STB) and open space (OS) between the hub and the spiral

Bird-eaters. There are records of many spiders that catch bats and small birds in their large sticky webs. Some spiders are known to have killed lizards, snakes and frogs. Mygalomorph spiders of the family *Avicularidae* are true bird catchers. They run with great speed on vertical tree trunks and have very strong fangs with highly effective proteolytic enzymes to kill and digest the captured birds.

The Australian funnel-web spider, *Atrax robustus*, is a venomous and a very aggressive spider that assumes a "fighting attitude" with its front raised and fangs extended out. The venom is very toxic to the vertebrates. The spider does not flee at the approach of danger and cannot be cornered so easily.

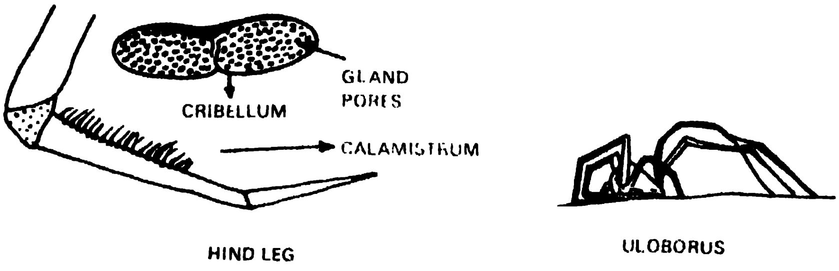


Fig. 8. Shape of a cribellum and calamistrum

Scavengers (*Museum pests*). Although spiders catch only live preys, yet *Herpyllus blackwalli*, a Gnaphosid spider, feeds solely on dead or dying insects. Professor B. J. Kaston of U.S.A. reports that this spider often eats the lepidopterans fixed on stretching boards by insect collectors. The sense of smell in this 'museum pest' plays an important role in locating the prey.

Commensals and parasites. Commensalistic and parasitic spiders are not so well known, although many studies have been recorded recently. Some small spiders feed on preys that fall on the webs of other spiders and live as commensals on the webs. The well-known ones are Conopisthine spiders that are found on the webs of many other spiders. Species of the genus Argyrodes also live on the webs of many other spiders. They steal preys from the host web by using certain methods or tricks. They are often termed as kleptoparasites. The small preys are actually captured by the host spider and kept in reserve in the web for future use. But these food packets are detached and stolen from the web by the kleptoparasites. *Uloborus* spiders have been recorded by the author to live as commensals on the web of social spider *Stegodyphus sarasinorum*. These commensals capture and feed on small preys that are generally overlooked and neglected by the host spiders.

Silk-eaters. Those spiders that wrap prey in silk (Fig. 5) feed not only on the prey but also digest the silk that covers it. However, males of some spiders feed on pure silk. As soon as they charge their palps with seminal fluid from the sperm web (a minute triangular web made

Spiders vs beetle

IT has to eat and that has to avoid being eaten. This is perhaps what happens in nature where there is no dearth of enemies of an organism. There is a harsh life-and-death struggle. One of the most fascinating tricksters to catch their preys are the spiders : some make a web and wait for a prey to come and get entangled in the silken threads. Others wait silently and jump onto their prey at first sight. Nature is wonderful! It gives chance to every one to defend—through natural selection of course. Bombardier beetle (*Brachinus*), as it is commonly known, has evolved a typical chemical armoury to defend itself against its enemy, the spiders. The tip on the abdomen of this beetle is revolving, and housed there is a pair of glands containing an explosive mixture of phenols and oxygen. If ever the beetle is trapped into a web of the spider of the genus *Nephilia*, the spider immediately runs to feast. Feeling pressure of the jaws, the beetle directs its abdomen towards the enemy, takes aim and fires with a small but laudible bang. The spider finds itself in trouble; it gets busy in cleaning itself, and meanwhile the beetle escapes.

Being well-equipped with this sort of a chemical defence, *Brachinus* is less likely to have many enemies. If, however, there is anyone to fool this bettle, it is a spider of the genus *Argiope*. *Argiope* is very alert. It does not bite the beetle trapped into its web immediately. Instead, it first gently spins a silken cocoon around its prey so that the latter does not know of it. When the beetle is completely immobilized, *Argiope* bites and takes her full dinner.

Z.I.

by the male spider for depositing a drop of sperm on it that finally is absorbed by the palpal organs), they tear and collect it into a small bundle and pass it on to the mouth to serve as an additional source of nourishment. The spiders of the family *Dinopidae* also feed on silk balls made out of their torn webs that have been used for catching preys during the night.

The wrapping of the prey by many spiders is very intersting. The spider is capable of avoiding personal injury from the live prey and a lot of time is saved in subduing the prey that could be left safely in the web to tackle more victims that fall in the web.

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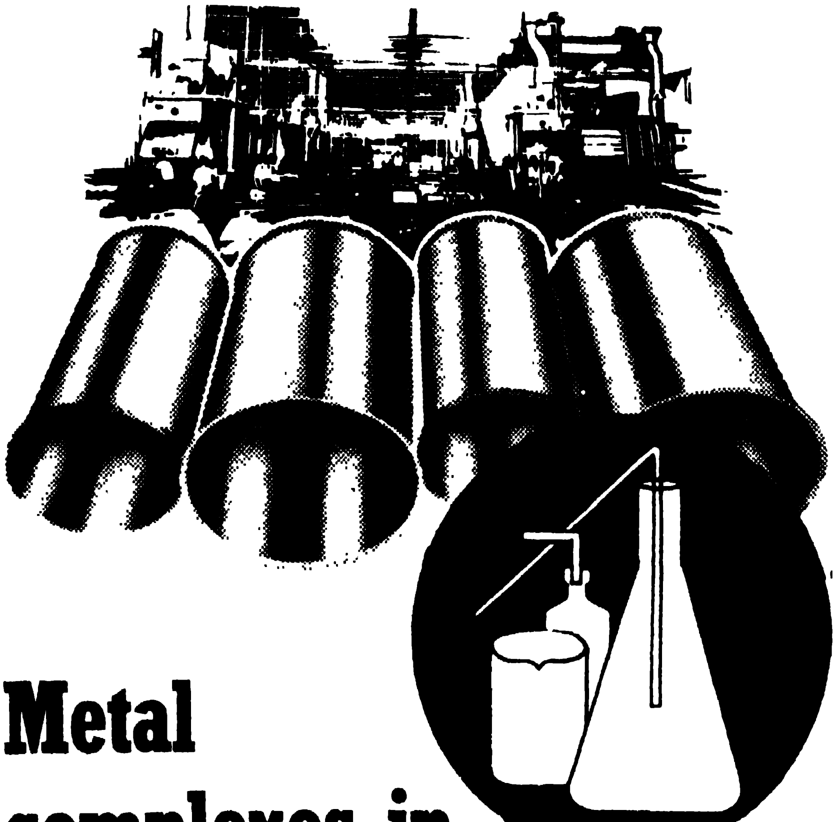

Metal complexes in analytical chemistry and industry

Metal complexes are gaining increasing importance in industry and analytical chemistry

IMAGINE a world without metal complexes! It would be far beyond anybody's imagination. It would be a lifeless world, because the two important substances, chlorophyll and haemoglobin, vital for life processes, are metal complexes. By virtue of their nature, the metal complexes exhibit special properties. Chlorophyll, found in green leaves, is able to use solar energy to convert carbon dioxide and water into starch and oxygen. Similarly haemoglobin in blood is able to store, transfer and later release oxygen.

Metal complexes and their applications has been an attractive field of research for beginners as well as established scientists. This is clear from the fact that every year thousands of new metal complexes are added to the existing list.

Origin and understanding of metal complexes

Though the initial uses of the metal complexes were as dyes and pigments, the exact origin of these complexes is not clear. Alizarin dye and prussain blue are the two long known coloured complexes. Prussian blue, an artist's colour, was made accidentally when animal wastes and sodium carbonate were heated in an iron container. Alizarin dye was prepared from madder and clay. Alizarin dye, as we now know it, is a calcium-aluminium (ions present in clay) complex of hydroxyanthraquinone(from madder), while prussian blue is a complex of ferric iron with potassium ferrocyanide.

The understanding of metal complexes goes back to 1798 when chemists started studying the reactions of metals with ammonia. Many metals interact with ammonia to give compounds which exhibit unusual valences (combining capacity) for the metal ions. For example, when spirits of ammonia are added to cupric chloride ($CuCl_2$) and the resulting contents evaporated, beautiful blue green crystals with a composition of $Cu(NH_3)_2Cl_2$

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are formed. Copper is divalent in $CuCl_2$ and it appears to be tetravalent in the new compound. What intrigued the early chemists was how ammonia molecules were held to copper when both the valences of this atom were already used up in the bonds with chlorine atoms. Similar is the case with the interaction product of ammonia with $CoCl_3$. This is a compound represented by $Co(NH_3)_6Cl_3$. Cobalt is a typical trivalent element, but in this compound it seems to exhibit nonavalence. Many other metals are found to exhibit such preposterous valences.

Later, Alfred Werner gave an explanation based on primary and secondary valences. According to him, after saturating their primary valences (e.g., chloride ions in the above two examples), metals can still display additional valence (NH_3 molecules). N.V. Sidgwic (1927) made an important advancement by extending the contributions of G.N. Lewis (1916) to the theories of bonding by extending them to metal complexes. The approach was extended by Linus Pauling in 1939 into the valence bond theory which could successfully explain many properties of complex compounds. Still, certain facts were not tenable by this theory. Towards the end of 1950's the electrostatic field theory (also known as crystal field theory) and the ligand field theory were revived by the early works of J.H. Van Vleck and H. Bethe. The molecular orbital theory was also being developed from 1935. Though in principle, this is the most exact theory, the other three theories are generally used for complex bonding, in view of the difficult calculations involved in it.

Metal complexes and stability

Compounds such as $Co\,(NH_3)_6\,Cl_3$ are called complexes. In fact, the cation $[Co\,(NH_3)_6]^{3+}$ is a complex. Similarly, the anion $[Pt\,(Cl)]_6^{2-}$ is a complex in the compound K_2PtCl_6. In a broad sense, a metal complex entity can be defined as a molecule or ion in which there is a metal atom or ion to which are closely attached other atoms or groups. The atoms attached to the metal are called donor atoms or coordinating atoms. Three important donor atoms are N, O and S. The groups containing donor atoms are called ligands. The coordination number of the metal defines the number of atoms or groups attached to the metal. The most common coordination numbers are 2, 4 and 6. The entity containing the metal and its ligands is called the coordination sphere.

When a metal complex is formed, the metal ion does not exhibit its usual properties because it is no longer free to do so. It is complexed by the ligands. Many properties of the complexes are due to the ligands, the nature and number of the donor atoms, and the charge on the ligand. The ligand can have one donor atom and be unidentate, or the ligand may have two donor atoms and be bidentate. When the ligand contains two or more donor atoms, the resulting metal complex is called a chelate because chelates are ring compounds. If the sum of the negative charges of the ligand is equal to the charge on the metal ion, the resulting complex is uncharged (neutral), otherwise it is either positively or negatively charged.

How to discern complex formation

As many ligands are either weak bases or acids, the formation of a metal complex from a metal ion M^{n+} and an acidic ligand HA can be represented as

$$M^{n+} + nHA \rightleftharpoons MA^{n+} + nH^+$$

for the formation of the neutral complex. In general, any property of the system which is related to the concentration of one of the species involved in the complex formation (H^+, metal ion, ligand or the complex) may be used to show complex formation. The experimental observation that metal ions do not exhibit their usual reactions is a positive evidence that the simple metal ion is present in extremely low concentration and that most of it is associated with the ligand in the complex. For example, if you add an alkali to a solution of a ferrous salt in the presence of ethylenediamine tetraacetic acid (EDTA), the familiar green $Fe(OH)_2$ does not precipitate, because the free Fe^{2+} is so small that practically all of it is in the form $[Fe(EDTA)]^{-2}$. Otherwise expressed, the iron-EDTA complex is very stable. Similarly, Cl^- does not cause precipitation of Ag^+ from aqueous ammonia solutions because of the high stability of $Ag\,(NH_3)_2^+$. However, the complexes between NH_3 and Ca^{2+}, Zn^{2+} or Al^{3+} give all the usual precipitation reactions of the free metal ions. This is because the complexes are not highly stable, which means that appreciable amounts of the simple metal ions are left uncomplexed by ligands in these complexes. The stability of a complex defines the extent to which the formation of the complex takes place.

Complex formation sometimes associates itself with the appearance of bright colours. When a drop of 1, 10- phenanthroline is added to ferrous iron, brilliant red colour develops because of the formation of the complex, ferroin. In some cases, coloured metal ions may lose their colour by the formation of colourless complexes. Colour may be a way of discerning complex formation. Isolation and characterisation of the complex is the best way to show complex formation. Changes in hydrogen ion concentration and conductivity measurements help identify complex formation in some cases. Other methods like optical activity, ion exchange absorption, oxidation-reduction potentials, kinetic rate expressions, polarography, magnetic susceptibility, IR and NMR spectral studies also help in the study of complex formation.

Factors affecting complex formation

Why metals form complexes still remains to be answered satisfactorily. There are no hard and fast rules to predict when complexes would form. At least some of the factors can be considered. According to the Lewis theory, an acid is ane lectron-pair acceptor and a base, an electron-pair donor. Thus, a metal ion can be considered as a polybasic acid capable of reacting with several basic entities depending on its coordination number The formation of a metal complex depends on the acidity of the metal ion, the basicity of the ligand and the configuration of the resultant complex. Generally, 5 or 6-membered rings are highly stable and hence the functional groups in the ligand must be so situated as to form stable rings. Complex formation is sometimes sterically hindered when bulky atoms or groups present close to the donor atom in the ligand do not allow it to approach the metal to form bond. For example, 1, 10-phenanthroline forms a chelate with Fe^{2+} whereas neocuproine (the 2, 9 - dimethyl phenanthroline) does not form a complex.

Metal complexes in analytical chemistry

Analysts are fortunate that complexing agents come to their rescue and help them finish otherwise difficult and time consuming analyses easily in a short time. Metal complexes have one or more of the following characteristics: low solubility product in aqueous medium, high stability, solubility in organic solvents, intense colour, etc. These characteristics form the basis for analytical techniques such as gravimetry, titrimetry (complexometry, photometry and redoximetry) and solvent extraction. Various instrumental methods of determination like polarography, flame photometry and atomic absorption spectrophotometry also make use of metal complexation at one stage or the other. Metal ions can be separated from solutions and can be estimated by means of electrogravimetry making use of complex formation.

Gravimetry and complexation

The principle of gravimetry consists in precipitating the species concerned as completely as possible in the presence of a suitable reagent, filtering off and washing the precipitate and finally drying or igniting and weighing as a compound of known composition. Many complexes themselves are used as precipitating agents. For example, ferrocyanide ion $[\mathrm{Fe(CN)_6}]^{4-}$ forms sparingly soluble salts with many metal ions including 2n^{2+} and Cu^{2+}. Similarly $[\mathrm{Co(NO_2)_6}]^{3-}$ is useful for separating K$^+$ from Na$^+$ by precipitation. Hexachloroplatinum (IV) and $(\mathrm{AuCl_4})^-$ are convenient precipitants for organic amine salts. Dimethylglyoxime is an important complexing agent used for estimation of nickel. Precipitation is carried out in ammoniacal solution and the complex is weighed after drying at 110°C-120°C. The interference of iron, aluminium or bismuth is eliminated by the addition of a soluble citrate or tartrate which forms soluble complexes with these metals. This is called masking and

Titrimetry and complexation

Complexation forms the basis for several titrimetric methods of analysis, the important ones are complexometric, photometric and redox titrations.

Complexometric titrations. These involve the formation of a soluble, slightly dissociated complex, as in the titration of a solution of cyanide with silver nitrate ($2\,\mathrm{CN^-} + \mathrm{Ag} \rightleftharpoons [\mathrm{Ag(CN)_2}]^-$ or of chloride ion with mercuric nitrate solution. ($2\mathrm{Cl^-} + \mathrm{Hg^{3+}} \rightleftharpoons [\mathrm{HgCl_2}]$) Ethylenediamine tetraacetic acid (EDTA) is one of the most important reagents in complexometric analysis. This reagent can be used to determine most of the metal ions either alone or present in admixture by selecting suitable pH, metal ion indicator and masking agents. EDTA titrations can be classified into four groups: direct titrations, back titrations, substitution titrations and alkalimetric titrations.

Photometric titrations. These titrations make use of the linear dependence of colour intensity of the complex on its concentration As the titration proceeds in a suitable assembly of apparatus, the colour of the species is measured at suitable wavelengths. The results, when plotted as optical density vs volume of titrant, give two straight lines intersecting at the end point.

Redox titrations. The redox potential E of a system

$$\underset{\text{oxident}}{\mathrm{Ox}} + \underset{\text{electrons}}{ne} \rightleftharpoons \underset{\text{reductant}}{\mathrm{Re}}$$

is given by $E = Eo + 0.0591/n \times \log [\mathrm{Ox}]/[\mathrm{Re}]$ at 30 C. E is a measure of the oxidizing capacity of the system in question. The redox potential of a mixture of ferric and ferrous ions:

$$\mathrm{Fe} \quad e^{+} \quad \mathrm{Fe^{2+}}$$

is given by $E = Eo + 0.0591 \log [\mathrm{Fe^{3+}}]/[\mathrm{Fe^{2+}}]$ at 30°C.

It is evident that the redox potential depends on the ratio of the ferric ions to ferrous ions. The value of E can be increased or decreased by changing this ratio. We know that ferric ions form complexes with fluoride and phosphoric acid. Addition of fluoride to a ferric salt decreases its oxidation potential and consequently its oxidizing capacity. In the presence of fluoride, ferric ion can no longer oxidise iodide to iodine and, in fact, this normal reaction is reversed and ferrous ions reduce iodine to iodide in presence of fluoride. Such a reversal of normal reactions is an important application of complex formation in redox titrations. Another important use of complex formation is the acceleration of an otherwise slow reaction. For example, the addition of phosphoric acid accelerates the reduction of molybdenum (VI) to molybdenum blue by a number of reducing agents. A third application of complex formation in redoximetry consists in the stabilization of unstable valence states, as exemplified by the stabilization of unstable Mn (III) with pyrophosphate during the oxidation of Mn (II) with potassium chlorate or bromate.

Solvent extraction and complexation

Solvent extraction is a versatile technique employed in analytical chemistry for the separation and determination of various species. The technique involves removal of a metal ion from an aqueous solution into an immiscible organic solvent as its metal complex. The water solubility of metal salt is because of the water molecules associated with the metal ions. When complex formation takes place, these water molecules are either wholly or partly replaced by the reagent molecules reducing the water solubility of the metal salt. The uncharged complexes so formed can be separated by organic solvents. Since the metal complexes are sufficiently coloured, determination of the metal ion s can be made by measuring the colour. A typical example is the determination of nickel as dimethylglyoxymate in chloroform by measuring the colour of the complex at a wavelength of 366 nm.

However, the colorimetric determination of a metal ion in a mixture of metals often suffers interference because the reagent may form coloured complexes with all the metals and carry them into the organic solvent. Such difficulties are eliminated by suitable choice of pH and masking agents. For example, in the determination of uranium as 8-hydroxyquinolinate many interfering agents like iron and aluminium are masked by EDTA as their water-soluble complexes.

Miscellaneous applications

A relatively recent application makes use of the rates of formation or decomposition of metal complexes for quantitative determinations. An example is the determination of Ni^{2+} in the presence of Cu^{2+} . Both the ions form complexes with α-amineoxime. On addition of EDTA to these complexes, the metal-EDTA complex forms rapidly in the case of Cu^{2+}, but slowly with Ni^{2+}. The absorption spectra of copper and nickel α-amineoxime complexes overlap (as well as the two of EDTA) at most frequencies, but Cu-EDTA and Ni-α-amineoxime do not overlap which enables determination of both Cu and Ni in a mixture.

The organic chemist uses complex compounds in many preparative reactions like Friedel-Crafts reaction, Grignard reaction and Sandmeyer reaction. In physical chemistry, complex compounds formed the basis for understanding the theories of bonding and kinetic behaviour, electrolytic behaviour, magnetic behaviour, etc. In biochemistry too, complexes are a subject of intensive study. Hemin and chlorophyll-a contain coordinated Fe^{2+} and Mg^{2+} respectively, while vitamin B_{12} contains cobalt. The activity of many enzymes is traced to the metal ions present.

EDTA

THE ability of chelating agents to reduce the chemical activity of certain metal cations has found extensive application in many areas of science. The hexadentate (having six coordinating groups) chelating agent, ethylenediamine tetraacetic acid (EDTA), has found a wide commercial market. EDTA may be used in :

* Water softening, because of its ability to form stable chelates with Ca, Mg and Fe ions.

* Separation of rare earth ions.

* Leather tanning for clearing, stripping and removal of stains by forming complex with Ca, Cr and Fe ions.

* Medicinal preparations, as blood anticoagulent due to its property of complex formation with Ca.

* Prevention of colour distortion in metal dyes due to impurities (Fe, Cu, Ni, hardwater metal ions).

* Control of rancidity in soaps by reducing oxidative effect of transition metals.

* Improvement of flavour retention in carbonated beverages.

* Prevention of surface discolouration, stabilization of ascorbic acid (Vit. C) and removal of spray residues in fruits and vegetables.

Complexes in chemical industry

As dyes and pigments An age old application of coordination compounds is as dyes and pigments as is evident from the accidental discovery of prussian blue and alizarin dye.

As catalysts. Coordination compounds are known to influence the course of polymerization so as to produce plastics with desirable properties including higher softening temperatures and greater strength.

Ion control. Often, it becomes necessary to control concentrations of the metal ions which cause undesired reactions. This can be achieved either by physical removal or by sequestration. In sequestration, the reactivity of the metal ions is suppressed without physically removing them. This is achieved by complexation. The Raschig synthesis of hydrazine involves interaction of hypochlorite with ammonia. The yield of hydrazine is however greatly reduced if copper ions are present because of metal-catalysed side reactions. EDTA suppresses the harmful effect of these metal ions through chelate formation. Another interesting example where the undesirable effect of large quantities of metal ions (particularly Ca^{2+} ions) is suppressed is the conditioning of water by agents like EDTA. The chelated calcium ions do not precipitate with soap, EDTA is added to liquid soap for haze prevention; to hydrogen peroxide for prevention of catalytic decomposition, and to wines for prevention of turbidity. Calcium-EDTA complexes are also used in the treatment of lead poisoning.

Rigorous control of ion activity is also necessary in metal plating for obtaining smooth coherent plates. This is achieved by the addition of complexing agents; for example, cyanide ion is added in silver plating.

Separation and purification of metals

Many industrial processes of separation and purification of metals are based on complex formation. The alkylphosphoric acids are useful in the process of recovery of uranium from low grade materials. Certain metals like Ce^{4+} and Au^{3+} are easily extracted into ether from strong nitric acid solutions. Tributylphosphate is a useful complexing agent in the separation of zirconium and hafnium.

Conclusion

The importance of coordination complexes in laboratory as well as industry can be seen from the large consumption of the single versatile complexing agent, EDTA. Every year, millions of kilograms of this compound are utilised throughout the world. Metal complexes can be made to suit any purpose, provided the right type of complexing agent is selected. The utility of the metal complexes is limited only by the synthetist's ability to make a suitable organic reagent that is specific in respect of its particular use in the laboratory or industry.

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SCIENCE SPECTRUM

Communication via meteor trails

FREAK receptions of television signals from transmission stations at long distances are not uncommon. In fact, not long ago such receptions of transmissions from Philippines were reported by Madras TV viewers. This effect arises from what is known as ionospheric scattering.

Apart from reflection, the ionosphere can cause scattering of radiowaves because of minute inhomogeneities in refractive index. Also, the distribution of electrons even within a narrow altitude range is not uniform and quite frequently small regions, in which the electron density is larger than that in the surrounding atmosphere, exist. Such regions can scatter electromagnetic waves of very high frequency, as particles of dust, moisture, etc., do. If the dimensions of these regions with higher than average electron density are greater than the wavelength of the radio waves, there will be a tendency for preferred scattering in the forward dirction, i.e., in the direction in which the waves are travelling resulting in increasing the range of reception of the transmitted signal. Besides the inhomogeneities in the ionospheric electron density, meteors impinging on the terrestrial atmosphere produce 'meteor trails' of very high electron density that can cause scattering of radiowaves. It should be noted that ionospheric and meteor trail scattering occurs only in waves which are not normally reflected by the ionospheric layers (i.e., wavelengths less than 10 m).

Although the freak reception of television signals from long distances is of little value, the meteoric signals (scattered waves from meteor trails) received at distances of several hundred kilometer are found to be sufficiently numerous to support almost continuous communication. In fact, practical communication systems of VHF radio waves over distances of 1000 to 2000 kilometres have been developed at various places. Let us now know some details about these meteor trails and communication by meteor trail scattering.

Meteors as we know are celestial phenomena associated with a streak of light of very short duration. They are commonly known as shooting stars. The bright light associated with the meteor results from the heat generated when a particle of matter travelling at a high speed in space enters earth's atmosphere. Earlier it was thought that the heating of the atmosphere and the consequent production of visible light and ionization is caused due to compression of air in front of the fast moving meteor. However, the small dimensions of the meteoroid particles and the low density of air at meteoric heights (above 80 km) make this explanation unsatisfactory. The most commonly held view is that the individual molecules and atoms of the atmosphere bombard the surface of the meteoroid and their kinetic energy is converted into heat. The temperature of the solid is thereby raised to the point where its surface begins to vaporize. The vaporized meteoroid atoms move into surrounding atmosphere at about the same high velocity as the solid particles from which they originate, and collide with atoms and molecules of the air. In these collisions the directed kinetic energy is converted into random kinetic energy, i. e., into heat, and this heat produces both light and ionization. The resulting ionized region is capable of reflecting radio waves. The ionized gases form a trail behind the meteor. Every day millions of meteors hit the earth's atmosphere, producing ionized trails at 80-120 km altitude. It is observed that clearly discernible meteor trails are produced by particles weighing more than 10^{6} gm and with a radius more than 0.008 cm each. The ionization in meteor trails is initially in the form of long, thin columns with electron density about 10^{10} electrons per cubic centimetre, having a diameter of about 10 cm. But these trails rapidly expand with the passage of time owing to molecular diffusion and forms large patches or clouds of dense ionization. Turbulent diffusion leads to a still further expansion and the convection cur-

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rents and wind twist the originally straight trail into curves. The aggregate effect of these ion clouds is confined within a narrow region (80-120 km) just below and partly overlapping the E layer of the ionosphere.

A radio-wave incident on these ionized columns gets reflected from the trail during the period in which there is sufficient ionization. The scattered intensity depends on the diameter of the ionized column—whether it is large or small compared with the wavelength of the incident wave, if we assume the trail as having a shape of a long cylinder of intense ionization. If the radius of the trail is small, the scattered wave has the same phase as that of the incident wave. The duration of the reception of the scattered signal depends on the life of the meteor trail. For a given meteor shower of homogeneous velocity the duration is found to vary between 0.1 sec. to 100 sec.

An important thing to be noted in this type of propagation is that the reflection of signals from 'nearly formed' trails is highly directional and looks more like 'specular reflection' than scattering. That is why more often people prefer to call it reflection rather than scattering. The waves incident on meteor trails are mainly reflected in the direction for which the angle of reflection equals the angle of incidence. Therefore, out of many meteor trails formed, only those suitably oriented may be used for communication.

As meteor trails generally live for only 0.1 to 100 sec. and the trails capable of reflecting signals in the desired direction do not occur continuously, special techniques were devised—first to determine when suitable trails are available and, second, to transmit intelligence. For this, unmodulated carrier wave is transmitted continuously from a place. The reception of this carrier at a wanted distant place indicates that a suitable path has been established. The output of the receiver at this situation triggers a transmitter and the information to be transmitted travels to the first point via the same trail. In the same way, signals from the first station can be transmitted to the second, thus completing the communication link between the two stations. Transmission of intelligence only while a path exists is accomplished by storing the information in memory devices, say a magnetic tape. When the link is established, the tape is run at a high speed making the signal strength above a predetermined level.

As already mentioned, everyday millions of meteors come into the earth's atmosphere producing ionized trails and it is possible to have a fairly continuous communication link. The meteor-scatter links are very useful for point-to-point communication of messages, mainly for defence communications. Because the transmission is highly directional, with proper design and orientation of the aerial system it is possible to establish communication link between two points and the signals cannot be received at any other place. Moreover, the meteor-scatter links operate on VHF (very high frequency—above 30 MHz) band well above the maximum usable frequency for ordinary high frequency propagation via the ionosphere and are much less vulnerable to sudden ionospheric disturbances (SIDs). Another important advantage is that these systems work well with low power transmitters, usually less than 500 watts and simpler aerial systems.

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Random numbers

We had several interesting articles in the earlier issues of *S.R.* on Positional Number System (*S.R.*, Aug. 1975), Friendly Numbers (*S.R.*, Nov. 1975), The Waring Conjecture (*S.R.*, Jan. 1975), etc., and in this article we will see another type of numbers called Random Numbers. Number arithmetic has always been a fascinating field of study and Indian mathematicians like Ramanujam, Leelavathy and others are famous names in this field. Playing with numbers is a fruitful game indeed!

What is randomness?

We associate randomness with a madman's walk or drunkard's walk and so it appears that randomness has no use for sane persons. But, surprisingly, we find that many events in everyday life are random processes, say, the throwing of dice, the tossing of coins, the shuffling of cards, the arrival of cars at a junction, the Q length in a service counter, the molecular motion, etc. So a scientific study of the random phenomena becomes important for finding the method in the so-called madness or randomness and predicting the probability of the future course of events. It is found that random events can be simulated by the use of random numbers and hence the random number generation has become a highly sophisticated mathematical game. Not only the random numbers are useful in the simulation problems, but also in solving certain types of mathematical equations using what are known as Monte Carlo methods.

What are random numbers?

Strictly speaking, random numbers are best generated by picking numbers from a hat. But this method has the disadvantage of not being reproducible, though the numbers so generated have all the virtues of randomness. Philosophical models are rarely practical. Practical models use well defined reproducible methods for generating random numbers. In fact, the numbers are not really random, since the sequence is completely determined in advance and so they are called pseudo random numbers; but they work well in simulation and other applications—that is, after all, what matters to us in real life. The pseudo random numbers satisfy certain statistical properties and these characteristics are taken as the standard for finding out whether a particular formula gives a generous supply of random numbers for practical applications.

The following are some of the methods employed for generating random numbers :

Seed-multiplier method. In this method any two numbers are selected at random. One is called the seed and the other is called the multiplier. The procedure for generating four digit random numbers is given below :

Let the seed be 2786 and the multiplier be 6345

Product : 2786 × 6345 = 17 6775 70

Then the random number is 6775, the seed is 1767 and the multiplier is 7570

Product : 1767 × 7570 = 13 3761 90

The random number is 3761, the seed is 1337 and the multiplier is 6190. The above procedure can be continued until the required number of random numbers is generated.

Mid square method. In this method a number is taken and squared. The middle portion is taken as the next random number. This number is again squared and the middle portion is taken as the next random number, and this procedure is repeated until the required number of random numbers is obtained.

Let the first random number be 5765

Square : 5765 × 5765 = 33 2352 25

The next random number is 2352

Square : 2352 × 2352 = 05 5319 04

The next random number is 5319 and so on.

Power residue method. The most widely used method for generating psuedo random numbers is the power residue method or the modular multiplication method. This method has the virtue of generating numbers with long periods and good statistical properties. Generally, the number of random numbers which can be generated by any method is limited by periodicity and degeneracy. Periodicity can be defined as the length of random numbers beyond which the same sequence of numbers repeats. Degeneracy is the process whereby the generation of random numbers will stop abruptly or the same number will repeat over and over again.

For example, consider the mid square method when the first number X_1 is taken as 1000.

Then 1000 × 1000 = 01 0000 00

The next number is 0000 and so the process terminates abruptly.

Suppose the first number is taken as 0100

Then 0100 × 0100 = 00 0100 00

The next random number is also 0100; that is, the same number repeats itself endlessly. The above drawback can be controlled to some extent in the power residue method. The plan of this method is given by the formula

$$X_n = Cx_{n-1} \pmod{N} \quad .. \quad (1)$$

where C and N are two constant integers. The notation $y = 20 \pmod{7}$ means that y is the remainder or the residue when the number 20 is divided by 7. In this example the value of y is 6. Suppose in the number generator formula (1) we put $C = 5$, $N = 32$ and $X_0 = 1$. By repeated application of the formula we get the sequence as

$$X_1 = 5 \times 1 \pmod{32} = 5$$

$$X_2 = 5 \times 5 \pmod{32} = 25$$

$$X_3 = 5 \times 5 \times 5 \pmod{32} = 29$$

....

....

The first 12 numbers of the sequence are

5, 25, 29, 17, 21, 9, 13, 1, 5, 25, 29, 17.

We observe that the sequence repeats itself after eight numbers, which is obviously too small a period for the sequence to be of much practical use. We will now see how we can generate random numbers of longer periods.

Usually, the length of the period depends on the initial values of N, C and X_0. The length of the period is found to increase with N and so we would like to choose as large a value for N as possible. It must be mentioned at this juncture that it is extremely difficult to generate a large supply of random numbers by manual calculations and so one has to resort to computer methods for a copious supply of pseudo random numbers. It can be shown that the longest period attainable by this method is N/4, where N is a power of 2. So the choice of N is decided by the capacity of the human or the computer that we use for the generation.

Let us now see how the period is affected by the initial value of X_0. In the above example, if we use $X_0 = 2$, we get the sequence as

2, 10, 18, 26, 2, 10, 18, 26, 2....

which has a period of only 4 numbers. It is seen that for a given value of C and N, any other choice of X_0 yields the same period if X_0 is odd and half this period if X_0 is even. This means that the initial value of X_0 should be odd.

It can be shown that the longest period is obtained when C has the form $C = 8n \pm 3$, when n is any +ve integer and so, in summary, we can state the conditions for obtaining pseudo random numbers possessing the longest period as follows :

1. N should be as large as possible; the limitation being the capacity of the human or the computer usedfor generation.
2. $C = 8n \pm 3$, where n is any +ve integer.
3. X_0 is any odd integer.
4. In order that the sequence may have good statistical properties it is recommended that the value of c be chosen close to $\sqrt{N}$ although theperiod is not thereby lengthened.

Test of randomness

Having obtained a supply of random numbers we would like to test how random they are. We produce random numbers with the obvious intention of being impartial to any particular number or any particular region or range of numbers. (In fact, it is our social objective also to provide equality of opportunity to all, unbiased by considerations of caste, creed, region or religion, etc.). If we plot the number on a scale, they must show a rather uniform distribution without any obvious preference to any part of the scale. In other words, the number of random numbers or the frequency of random numbers in the region say, 1000 to 2000, must not be much different from the frequency in another range, say, 7000 to 8000. This is scientifically found out by calculating the standard deviation of the frequency and finding out whether that lies within the prescribed confidence limits. Of course, this is not the only test, for we can see that if the same numbers had been generated in a monotonically increasing or decreasing sequence, we would still get the same standard deviation for the frequency and so the standard deviation test alone would be misleading. So we have to make what is called a 'frequency run test'. A run of length 'k' consists of a string of k consecutive numbers, which is either monotonically increasing or monotonically decreasing. The test involves counting the occurrence of runs of different lengths appearing in a given sequence and comparing with the expected results by what is called the chi squared test. Modern computers intended for simulation applications are already provided with random number generation subroutines and so one has only to call SUBROUTINE RAND to get a supply of random numbers of desired characteristics.

Use of random numbers

Customers arrive in a random fashion at a service point, say a hair cutting saloon and if a previous customer is being served, they form a waiting line or queue. One may be interested to find how best the service point can be kept busy for maximum time and whether the rate of customer arrivals warrants another service point to be opened and so on. It is possible to stimulate the random arrivals of customers by using random numbers and in fact any random process which takes place in time can be simulated by using random numbers. Suppose 20 customers arrive on an average per hour for a service which takes 10 minutes to complete. The probability of customer arrival per minute is 1/3. To simulate the customer arrivals we consider a random number table of 5 digits in the interval 0 to 1 as shown below:

.03474	.37386	.97742
.63564	.16227	.79439
.57608	.60244	.18180
.46762	.16766	.25766
.84427	.75531	.63016
.79246	.26623	.89775
.12568	.59926	.55595
.43785	.33211	.23429
.23424	.06474	.52362

We choose a small interval, say 1 minute to correspond to every random number. We find that the first random number is .03474. Since it is less than the probability of the customer arrival which is 1/3, we assume that a customer has arrived in the first minute. The second number is .37386. Since it is greater than 1/3, we assume that a customer has not arrived in the second minute. Thus the process of customer arrivals can be simulated for any length of time, 3 or 4 hours. During this interval, the number of customers served, and the number of people in the waiting line can be found. If the queue length is continuously increasing, we can simulate the process by adding one more service counter and see how the queue length changes. It is easier to alter the different parameters like customer arrrival rate, service time, number of service points, etc., in a simulation model, than to make a change in the actual physical process itself. In summary, we can say that random numbers serve very useful purpose in the simulation of all random processes.

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Halogen lamps

ELECTRIC lighting has assumed a significant importance in our everyday life. Good and efficient lighting creates a warm and cheerful atmosphere. It has added a new dimension to the outlook, style and comfort of human life. We can no longer do without it. Every room of a building, laboratory, industry, auditorium, studio or sports ground requires illumination to avoid unnecessary strain on our eyes. Streets and roads also need proper illumination.

In India, energy used for lighting is approximately 2% of the total consumption of electric energy. However, in cities like Delhi, Bombay, Calcutta, the percentage consumption of electrical energy for domestic lights and fans is about 75% of the total domestic consumption and out of this, 60% is used for lighting only At present we have light sources which are almost 20 times more efficient than the initially discovered incandescent lamps However, a fairly recent development in this field has been the halogen lamps which came into production in the sixties.

We know how an ordinary incandescent lamp works (*S.R*, June 1976). An electric lamp is based on the principle of heating effect of current. When electric current is passed through a filament of an electric lamp it gets heated and emits light. The first electric lamp, invented by Edison in 1878 consisted of carbon filament enclosed in an evacuated glass bulb. But the luminous flux (light output) from this lamp was very small, nearly 3 lumen/watt only. Lumen is the unit of luminous flux or light emitted per second within a unit solid angle by the light source having a uniform intensity of 1 C.P. (candle power) so that 1 C.P. $= 4\pi$ lumens.

The efficient design of an incandescent lamp of reliable quality centres on obtaining a high temperature at the filament without sufficient loss of heat or disintegration of filament. In 1909, Coolidge introduced tungsten metal filament in a vacuum glass bulb. The light output of about 8 lumen/watt could be obtained from this lamp. Due to very high melting point, nearly 3400°C, the tungsten filament can withstand sufficiently high temperature of about 3000°C without melting. In an evacuated lamp, however, the tungsten filament gradually and slowly begins to vaporise or disintegrate at about 2000°C resulting in blackening on inside of the bulb. The filament becomes thin. Also, it is not uniformly vaporized over its entire surface and so some weak spots are formed through which it may finally burn off. This reduces the life of the bulb.

Later in 1913, Langmuir introduced the coiled-coil filament type inert gas-filled lamp (initially with a single coil but later a double coil tungsten wire) by filling the evacuated glass bulb with a gaseous mixture, generally of nitrogen and argon at a very low pressure. The vaporized tungsten molecules strike the molecules of the filled rare gas and return back partially to the filament. In this way, the rate of vaporisation could be retarded and reduced considerably. Also, the filament temperature could be further increased thereby increasing light output with its life still retained. But some of the tungsten molecules still get deposited on inside the bulb, blacken it and reduce the luminous flux.

The modern coiled, gas filled lamps at the running colour temperature of about 2700K have the light source efficacy (formerly called light-source efficiency) of about 22 lumen/watt with an average life of about 1000 hours for general service Although at its melting point, tungsten can emit luminous flux of 52 lumen/watt but due to physical and practical limitations efficacy of 22-27 lumen/watt only can be obtained. In India, however, such lamps of light efficacy ranging from 10-18 lumen/watt at colour temperature of 2700 K and average life of 1000 hours have been designed. It may be noted that the higher the filament temperature and colour temperature, the greater is the light produced. Hence higher the light efficacy (lumen/watt), brighter (whiter) the light.

In halogen lamps, the vaporisation of the tungsten filament as well as the blackening of the bulb wall are reduced considerably by adding a minute quantity of halogen such as bromine or iodine to the gaseous mixture in the bulb. Here the free tungsten molecules which would otherwise be deposited on inside the bulb wall readily combine with the halogen by forming a volatile compound at the wall temperature lower than filament temperature. The volatile compound so formed gets decomposed again in the space around the filament so that the vaporised tungsten molecules get deposited on filament itself. The free halogen molecules recombine with tungsten molecules at the bulb wall and so a regenerative cycle is created inside the lamp. Halogen helps in bringing the vaporised tungsten molecules back to the filament without allowing them to be deposited on the bulb wall. The bulb becomes clear. Additionally, the bulb can be made quite tough and strong by reducing its size so that high pressure gas can be easily filled to reduce rate of vaporisation of the filament. Since the filament and bulb wall are quite close enough, the bulb is made of quartz glass which has a very high melting point. Therefore, the luminous flux and so the light efficacy of the lamp can be increased considerably with practically no light loss and the life of filament still retained. Tungsten filament halogen lamps made in India have light efficacy of about 22 lumen/watt at colour temperature of 3200K with an average life of 2000 hours.

Applications and special uses

The prospects of possible applications of halogen lamps in various fields are interesting. These areas include lighting applications such as indoor lighting (commercial, industrial and home-lighting) and outdoor lighting (street lighting and flood lighting), reprographics and heating engineering, etc. The halogen lamps may be used in general service lighting for light signalling, railways, sports grounds, swimming pools, parks, halls, auditoria, head-lights of automobiles and locomotives, light-houses, operating theatres, air fields and factories. They can also be used for efficient flood lighting of buildings, monuments and fountains where accurate beam control is required. For such applications, halogen lamps having very high luminous flux of approximately 10,000 lumens for a 500 W lamp upto about 250,000 lumens for 10 KW lamp have been developed in India.

Infra-red quartz halogen lamps may be used for drying paints, manufacturing safety glass, producing sanitary-ware or plastic mattings. They have also helped in designing heating ovens which are quite compact in size, light in weight and simple to operate. Special tubular halogen lamps also make rapid copying possible due to high luminous flux at a sufficiently high colour temperature. Miniature quartz halogen lamps for the purpose of slides and picture projection can be used in smaller and portable projectors. Special halogen studio flashlight lamps at colour temperature nearly 3200K are quite suitable for shooting colour film and TV pictures. Special types of halogen lamps have also been developed for rough service applications as showcase lamps, sign lamps, spotlights, insect control lamps and for severe vibration applications.

These days halogen lamps are also being used as photographic lamps, in medical (surgical and dental) instruments and as a heat source for soldering. They can also be used for the interior lighting of aircraft and for the illumination of scoreboards. In fact, the development and use of the halogen lamps has opened up a wide variety of possible applications in various disciplines. More valuable and interesting applications may be explored in near future.

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Chemicals in war

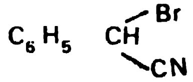
CHEMICALS can be used against any enemy to reduce his military effectiveness. Such chemicals can be incendiary, anti-crop weapons or toxic. Most weapons used to-day are chemicals. The explosion of T.N.T. (Trinitrotoluene) is a chemical reaction and so is the combustion of napalm. By chemical weapons, we mean those chemical agents which are based on the toxic properties of chemicals rather than on the energetics of their interaction.

The chemical agents used for chemical warfare can be broadly classified under the following heads depending upon the effect caused by them : (a) vomiting gases and lachrymators, (b) chocking gases, (c) nettle gases, (d) vesicants, (e) nerve gases or G-agents, and (f) incapacitating agents.

In the training manuals, vomiting gases and lachrymators are classified as riot control or harassing agents. They are irritant and are lethal only in very high concentrations. A famous example is CS (ortho-chloro-benzal malononitrile). Its effects are extreme burning sensation of the eyes and copious flow of tears, coughing, difficult breathing and chest tightness, nausea and vomiting. CS is more effective than the older agent CN (chloro-acetophenone) in that it supplements the latter's lachrymatory action with a more severe skin irritation and is more stable to store.

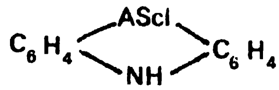
The agent known as CNS is a pre-war formulation of CN. It contains chloroacetophenone and vomiting agent chloropicrin dissolved in chloroform. A lengthy exposure to these agents is exceedingly unpleasant and painful. Soldiers are driven mad by the pain. Other important chemicals of this class are (i) CA (camite) and (ii) DM (adamsite).

CA(Camite)



$$C_6H_5\ CH\begin{matrix}Br\\ CN\end{matrix}$$

DM (Adamsite)



Camite is a pinkish to brown oily liquid. It produces burning sensation in mucous membranes, headache, severe eye irritation and lachrymatory effect. Adamsite is in the form of canary yellow to brownish green crystals and produces headache, sneezing, coughing, chest pains and vomiting.

Lethal agents

Choking gases or lethal agents are those which act by irritating the lower reaches of the breathing apparatus. Far from being merely harassing, their irritancy is sufficient to destroy the more delicate membranes of the lungs or respiratory passages. Lethal agents are classical agents of chemical warfare. They include chlorine, phosgene (CG), prussic acid (AC), sesquimustard (Q), and disulphur decafluoride. They are unlikely to be used in modern chemical wars because their initial irritancy or smell immediately warns of their presence.

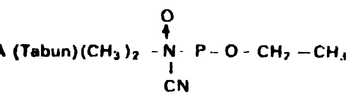
The nettle gases are primary skin irritants but more painful than those discussed above. A typical nettle gas is dichloro formoxime. At higher concentrations it blisters skin and penetrates into the blood circulation. There is probably no tactical need at present for nettle gases. Lethal agents must nowadays be imperceptible and therefore non-irritating, while riot control agents must be non-lethal.

Vesicants injure body tissues which they come in contact with. Their principal targets are skin and eyes which burn and blister. There are two classes of vesicants; first, arsenicals and second, mustards. The arsenicals, like various dichloroarsines, have sharp, irritating odours and cause immediate eye pains. Mustards have no smell and cause no initial pain. There are several different mustards ranging from comparatively volatile bis (β-chloroethyl) sulphide to the highly persistent α, bis (β-chloroethyl thio) alkanes.

Nerve gases or G-agents were developed by Germans shortly before and during World War II. They are quick killers with tremenduous potency. Some, like Tabun persist in the field whereas others like Sarin do not. Of the better known G-agents, Tabun is about half as toxic as Sarin and Soman about twice as toxic.

Some common nerve gases are:

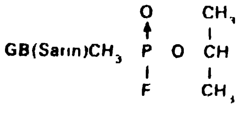
(i)



$$GA\ (Tabun)(CH_3)_2 - \underset{\underset{CN}{|}}{\overset{\overset{O}{\uparrow}}{N}} - P - O - CH_2 - CH_3$$

The colour of the liquid ranges from colourless to dark brown. Either it has no smell or smells fruity. It affects eye's pupil and shortens eyeball.

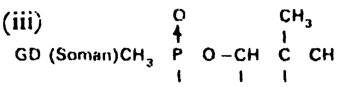
(ii)



$$GB(Sarin)CH_3\ \underset{\underset{F}{|}}{\overset{\overset{O}{\uparrow}}{P}}\ O\ \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{CH}}$$

It is a colourless liquid and produces chest tightness and difficulty in breathing.

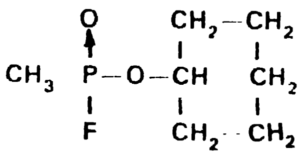
(iii)



$$GD\ (Soman)CH_3\ \underset{\underset{F}{|}}{\overset{\overset{O}{\uparrow}}{P}}\ O-\underset{\underset{CH_3}{|}}{CH}\ \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}\ CH_3$$

This liquid has smell slightly fruity to camphor-like. The symptoms of intoxication are nausea, vomiting, jerking, confusion, coma and convulsion.

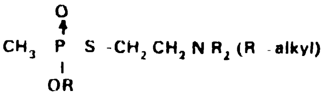
(iv) GF (CMPF)



$$\begin{array}{cccc} & O & CH_2-CH_2 & \\ & \uparrow & | \qquad | & \\ CH_3 & P-O-CH & CH_2 & \\ & | \qquad\quad | & | & \\ & F \qquad CH_2 & -\ CH_2 & \end{array}$$

It is a liquid. Its effects are drooling, sweating, nausea, vomiting, staggering, headache, confusion and coma.

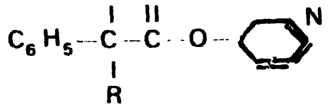
(v)



$$CH_3\ \underset{\underset{OR}{|}}{\overset{\overset{O}{\uparrow}}{P}}\ S-CH_2CH_2NR_2\ (R-alkyl)$$

In the physical state this compound is liquid. Incapacitating agents put the enemy out of action for several hours without permanently harming him, preferably in such a way that he needs no medical treatment. These agents are paralysants (denying movement), hypotensives (causing fainting), laxatives, and so on.

(vi)



BZ is another example of this class. It is a solid that slows physical and mental activity and produces giddiness, hallucination and disorientation.

Napalm

Napalm is gelled petrol. The name is derived from the first syllables of naphthenate and palmitate, the two fatty acids. Recently the term has been applied to a gel consisting of petrol, benzene and polystyrene which is also called Napalm B.

When mixed with a thickener, petrol changes from a thin volatile liquid into a tough, stable and sticky gel. Raw petrol is useless as an incendiary weapon. Napalm is ideally suited for this purpose.

Its adhesiveness, prolonged burning time and high burning temperature cause burns. Kidney failure may be another serious complication. In contrast to many modern weapons, napalm is produced from cheap, common ingredients and can be delivered through simple devices.

Defence

For defence against chemical agents, the toxic agent is chemically decomposed before it can enter the body. Ointments containing reactive chemicals should be smeared over the skin before an attack. There are powders for dusting on the contaminated skin after an attack. Clothings are impregnated with reactive chemicals. For collective protection, anti-gas squads with chemicals and spraying apparatus are used to destroy toxic agents deposited on the terrain.

Medical defence or prophylaxis involves the destruction of the toxic agent within the body before it can exert its toxic effect, or the reversal of its biochemical effect, or the biochemical protection of susceptible sites within the body.

While it is true that impermeable clothes have been developed and indeed supplied to soldiers as a standard equipment, the best gas alarms available can give no more than a few seconds warning.

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Surfactants the cleansing agents

THE problem of making things clean is of diverse nature. It ranges from washing hands with a toilet soap to removing heavy grease from roads and buildings, removing milk stains and egg residues from glass bottles and crockery, and washing off blood stains from surgeon's overalls. That is why a variety of cleansing formulations are available in the market to meet specific requirements. For example, milk stains on glassware can be easily removed by strongly alkaline solutions like sodium hydroxide or sodium silicate. Special chemicals, called tensides, become the agents of choice for dealing with oils, greases and finely divided particulate matter.

Use in industry

In many industries cleansing operations are a necessary part of the manufacture. In textile manufacturing, conversion of raw fibre into finished fabric involves much wetting and cleaning. Similarly, in metal finishing industries, thorough cleaning is of utmost importance. Metal articles that are to be plated or painted must be freed of all surface dirt for uniform and durable coatings. The food processing industry is yet another example where cleanliness plays an essential role. Fruits, vegetables, eggs and other foods have to be cleaned before packing.

Surfactants

The role of a surfactant is to promote emulsification and dissolution of oily and greasy matter from the surface. The surfactant wets particulate matter so that, upon application of mechanical energy as in a washing machine or by hand-scrubbing, the dirt is removed easily. The dirt removing capacity is substantially enhanced by the presence of builders. Builders are materials in synthetic detergents which chelate polyvalent metal ions present in cleansing solution. The most commonly used builders are the condensed polyphosphates, particularly pentasodium tripolyphosphate (STP), and to a lesser extent tetrasodium pyrophosphate.

A surfactant may be broadly defined as a substance that can reduce the surface tension in water solutions or which can reduce the interfacial tension between two liquids, or between a liquid and a solid. It is not easy to count the number of surfactants in current use. However, all surfactants have the same structure (Fig. 1). They are composed of a long hydrocarbon chain which is oil-soluble but water-insoluble (hydrophobic), and a terminal water-soluble but oil-insoluble (hydrophilic) part.

By nature, surfactants concentrate at the interface of the soil-water system with the hydrophobic part oriented towards the soil (Fig. 2). As a result, a marked reduction in surface tension occurs which promotes improved penetration, wettability or oil emulsification. Surfactants work at very low concentration and, in fact, fabric washing is carried out with an aqueous solution containing about 0.03 per cent by weight of surfactant.

Classification

Surfactants are classified into four groups based on the electrical charge present on surfactant molecules in solution. Anionic surfactants have a negative ion as their polar part while cationics have a positive ion. Non-ionics have no charge while ampholytics have either a negative or a positive charge depending on the pH of the solution.

Anionic surfactants. They are the least expensive ones and form the largest group of surfactants (70%). Soap is the oldest known anionic surfactant. Amongst anionics, dodecyl and tridecyl benzene sulphonates, allyl sulphates of C_{12}- C_4 chain length (coconut oil origin) alkyl sulphates of C_{16}-C_{18} chain length (tallow source), and the alkyl ether sulphates are most popular.

The hydrophilic part of anionics is either sulphonate, sulphate, phosphate or carboxylate Sulphates and

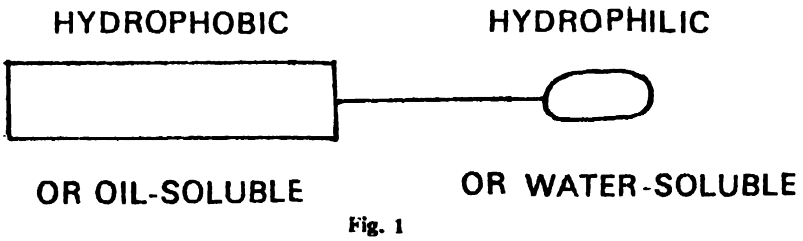


Fig. 1

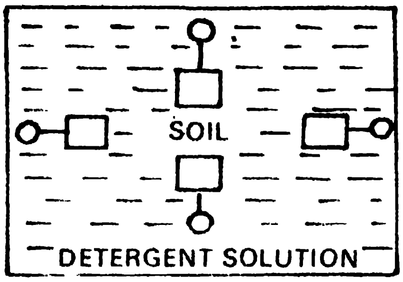
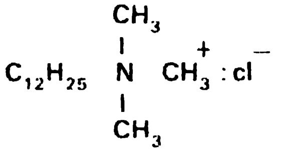


Fig. 2.

sulphonates are produced by reaction between the base hydrocarbon and sulphuric acid, 10%—30% oleum, SO_3 in a stabilized liquid form or chlorosulphonic acid under controlled conditions. The reactions taking place may be exemplified by the following sulphonation reaction (Fig. 3).

Cationic surfactants

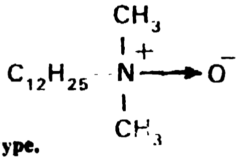
They constitute only about 4% of the total surfactant production, Salts of long chain amines and quarternary ammonium compounds are the common cationics. Trimethyl dodecyl ammonium chloride above carries a positive charge on hydrophobic part and hence is attracted to negative surfaces such as human hair and cellulose.


$C_{12}H_{25}\ \overset{CH_3}{\underset{CH_3}{\overset{+}{N}}}\ CH_3 : cl^-$

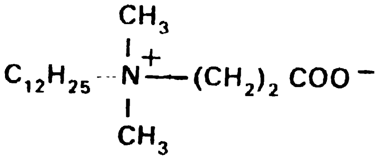
Non-ionic surfactants

The next most important class of surface-active agents is non-ionics. Non-ionics do not ionize in solution; Their activity depends on their structure. Hydroxyl, amide, ether and ester groups provide them a hydrophilic character. Non-ionics have an advantage over anionics in that they do not easily precipitate in the presence of calcium and magnesium ions.

Ampholytics. Ampholytics contain both anionic and cationic groups. They can be semipolar or Zwitter-ionic type.


$C_{12}H_{25}-\overset{CH_3}{\underset{CH_3}{\overset{+}{N}}}\rightarrow \bar{O}$

Semipolar type.


$C_{12}H_{25}-\overset{CH_3}{\underset{CH_3}{\overset{+}{N}}}-(CH_2)_2\,COO^-$

Zwitter-ionic type.

Applications of surfactants

Soaps and detergents. Soaps and detergents industry is the bulk consumer of surfactants. The development of synthetic surfactants is the most remarkable innovation that has occurred in soap and detergents industry. Synthetic surfactants have outperformed traditional soaps which were in vogue with reasonable effectiveness upto the late 1920's. However, the latter suffered from decided disadvantages like their poor performance in hard water. From 1930's onward chemists came out with thousands of new surface active agents with improved performance. As a result, the industry today buys most of its raw materials from the chemical and petrochemical industries rather than exclusively from agriculturally-based industries as it did in the past.

Soaps are fatty acid salts that can exhibit surface-active properties. They are made up of natural oils and fats (agricultural origin). Synthetic detergents, or syndets in short, are now made from synthetic organic compounds. Soap forms a curdy insoluble precipitate with hard water and hence its inability as a cleansing agent. Synthetic surfactants could replace soap particularly in case of heavy duty cleansing because the former do not form curd. However, soaps continue to be popular for mild cleansing and particularly for personal care.

Synthetic surfactants for cleansing applications are usually marketed as a mixture with builders such as sodium tripolyphospate, and diluents such as sodium sulphate. Household detergents may also contain various additives such as sodium carboxymethyl cellulose to prevent soil redeposition, optical

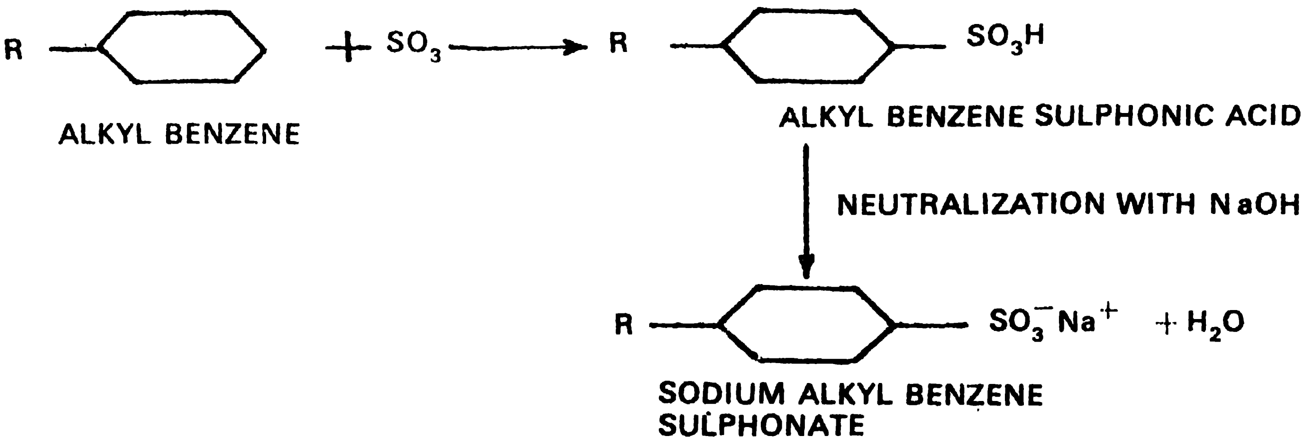


Fig. 3

brighteners and enzymes to reduce stains. As a result of successful formulation of synthetic surfactants into cleansing products, inedible fats, which were bought mainly by soap manufacturers earlier, are now used in animal feeds, special chemicals and lubricants.

Alkaline hypochlorites and soap-phenol or soap-pine oil mixtures were the only materials used in sanitation and disinfection before the development of synthetic surfactants. In 1935, chemists found that quarternary ammonium surfactants were highly effective against many of the common infectious bacteria and their use as germicides has since grown steadily.

Non-cleansing uses

In general, surfactants are useful wherever interfaces between different phases are to be modified. They find many non-cleansing uses of which wetting and emulsifying are important. When finely divided solids are stirred into a liquid medium, they tend to agglomerate into clumps and settle out. Inks, paints, ointments and cosmetic preparations are all dispersions of solids in liquids and for their proper functioning they should be stable. Manufacturers, since antiquity, have used a number of organic substances like gums, resins and tannins for obtaining proper dispersions. Modern surfactants find extensive use in emulsifying insecticides, fungicides and herbicides for easy application in dusts, wettable powders and sprays. Shortenings, cake mixes, salad dressings and various other emulsion preparations benefit from the presence of surfactants in their processing. Surfactants find place in petroleum industry for adjusting the viscosity of the drilling muds and in mining industry as conditioners and collectors for ore flotation.

Water conservation. In hot countries, loss of water from lakes because of evaporation is of serious social and economic concern. Cetyl alcohol was commercially exploited in Australia to prevent water loss in lakes as a result of a unimolecular surface-layer formed by the surfactant.

Environmental pollution control

There is a lot of concern in recent years about environmental pollution. Steps have been taken to produce materials that bacteria can biodegrade into innocuous end-products. Soaps and many synthetic surfactants (those having linear hydrocarbon nonpolar groups) are biodegradable. Unfortunately, the first alkyl benzene sulphonate household surfactants were non-biodegradable and the problem became serious by the late 1950's. As a result, the industry had to change to the biodegradable varieties of surfactants.

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Ground water contamination

THE accelerated pace of development has increased demand on our water resources. In areas where ground water is available, the increased demand is essentially met from this resource, particularly, for municipal supplies. Yet, the very uses for which water is utilized, viz., human needs, industry and agriculture, are adding contaminants to ground water reservoirs at an alarming rate. Implications of ground water contamination are not fully realised. It is generally accepted that ground water contamination is "irreversible", i.e., once it is contaminated, it is difficult to restore the original water quality of the aquifer over a short time span. It is therefore desirable to prevent ground water contamination. The matter assumes significant importance when it is realised that in several situations ground water is being directly used for human consumption without any treatment. The general belief that ground water is safe for human consumption as the soil mantle through which it passes acts as a filter and removes the harmful substances is not always true.

Contamination possibilities

Ground water contamination can occur from several sources. They are industrial wastes, solid waste disposal sites, waste water treatment lagoons, agricultural areas, mine spills, septic tank tile fields, etc. The type of contaminants added will depend upon each particular situation that is considered. Currently, there are no generally accepted limits to contaminants in ground water. The purpose for which the ground water is used dictates the allowable limits of contaminants.

Fig. 1, depicts potential sources of ground water contamination.

Domestic wastes

Domestic wastes and methods of their disposal are of primary concern in an urban situation. The quantity and quality of domestic wastes of an area varies, but the four prime factors affecting quality

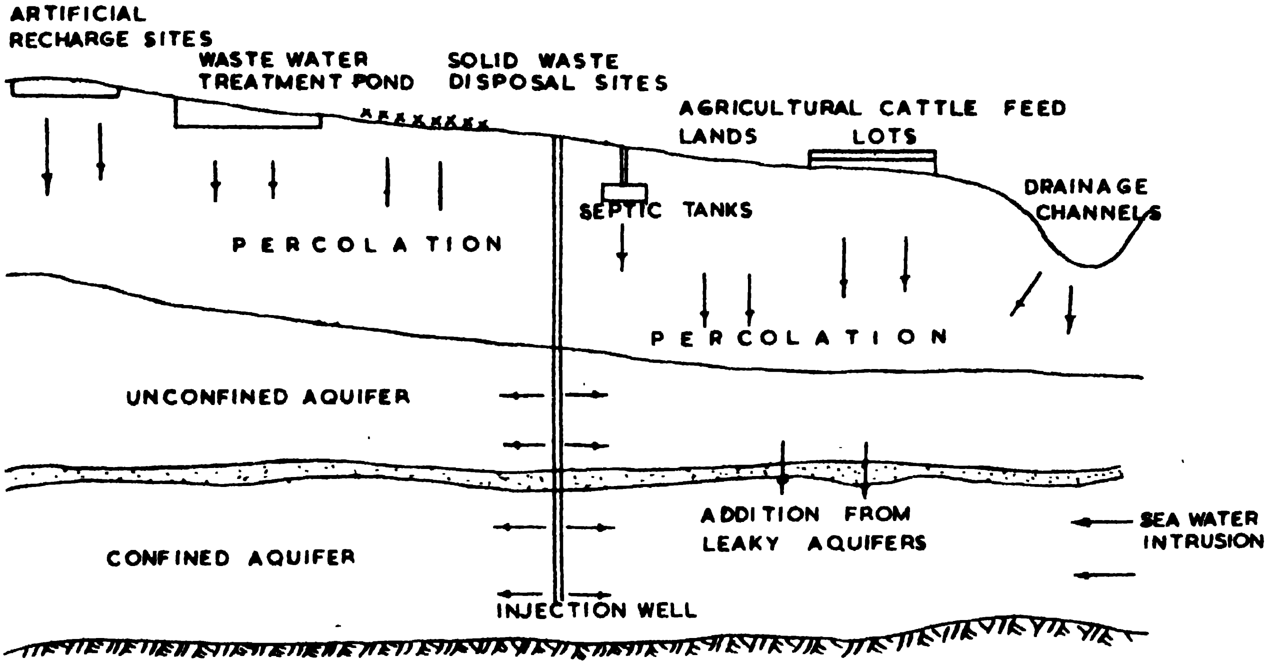

Fig. 1. Potential sources of groundwater contamination

are pathogenic organisms, oxygen demand, nutrients and solids. Nutrients, particularly nitrogen and phosphorus are of major importance.

Parts of the domestic wastes are taken to disposal sites as solid wastes. They are partly burned and partly incorporated in the soil. They are a potential source of ground water contamination and the leachates of the areas join the aquifers below. If the same aquifers are used for drinking water supplies, care should be taken regarding the movement of contaminants in these aquifers as there is a danger of contaminated water being drawn up.

Runoff from urban areas

The runoff from rainfall in the urban area is another potential source of contamination of ground water. It may contain relatively large concentrations of oil and grease, nutrients, pesticides and heavy metals. The runoff, where there are no proper outlets, could accumulate into small ponds and depending upon the subsoil strata may join the aquifers below. The rainfall in the city could also pick up substantial contamination from dust and air pollution before it reaches the ground. Its pollution potential is considerable and cannot be neglected.

Agricultural wastes

Wastes of agriculture can be significant in some areas. Agricultural wastes may be animal wastes, processing wastes and agricultural chemicals. A major problem in agricultural areas is the runoff from farm lands using large quantities of fertilizers. The contribution of agricultural wastes to ground water contamination appears to be marginal, but specific situations should be investigated.

Industrial wastes

Industry has become a part of several urban areas. Most industries, produce some wastes. Industrial wastes consist mainly of inorganic chemicals and heavy metals.

Industries also draw heavy supplies from ground water and also produce contaminants on a large scale. Wherever industrial complexes form a part of the urban environment, a thorough analysis of the ground water should be undertaken to assess its contamination.

Cases of ground water contamination

Cases of ground water contamination have been reported from several parts of the country. Aboo (1968) surveyed the quality of well waters in the city area of Bhopal

(M.P.). The survey showed that 24% of the wells had one or more of the chemical constituents in quantities higher than the permissible limits. Only 4% of the well waters studied showed less than 20 MP/100 ml of coliform bacteria, a bacterial count used as an indicator of water pollution associated primarily with excreta of warm blooded animals including humans.

In a study of ground water contamination in Anakapalle (A.P.), P.S. Rao and M.V.V Rao (1973) observed that the municipal water supply was contaminated as a direct consequence of indiscriminate discharge of industrial wastes into river waters. The organic waste effluents from the sugar-cum-distillery factory created anaerobic conditions in the river bed due to the bacterial decomposition of the organic matter which in turn reduced the insoluble ferric iron content of the river sand to soluble ferrous state. The soluble ferrous iron subsequently infiltrated into ground water.

In a recent study, the Industrial Toxicology Research Centre, Lucknow reported manganese contamination of well waters in nearby areas.

Though the studies reported are sporadic in nature, there is no doubt that ground water contamination is occurring at an alarming rate.

Protecting ground water

The following general steps are suggested for protection of ground water:

1. The contaminant sources as indicated earlier should be surveyed;
2. Location of a disposal site (either of industrial or municipal wastes) should be decided keeping in view the ground water levels and flow patterns in the area;
3. In case of likely presence of harmful constituents, particularly of industrial effluents, steps should be taken for pre-disposal treatment by the industry itself; and
4. Location of wells for drinking water supplies should be decided with utmost caution. Surrounding contaminant sources and flow directions should be taken into account. It is also not advisible to tap the uppermost aquifer in case of drinking water wells.

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Deterioration of ascorbic acid in diseased fruits

ASCORBIC acid (vit. C) an be synthesised by a variety of plants for their nutrition. The best source of this vitamin are guava, citrus, tomatoes, strawberries, raspberries, grapes, lemons, oranges and many green vegetables. Severe ascorbic acid deficiency produces scurvy and some other diseases. Fruits and vegetables are used to supplement this vitamin.

During pathogenesis a number of fungi such as *Botryodiplodia theobromae*, *Rhizopus nigricans*, *Aspergillus niger*, *Alternaria tenuis*, *Gloeosporium psidii*, *Phytopthora parasitica*, *Macrophoma allahabadensis*, *Drechslera australiense*, *Clathridium corticola*, *Cylindocladium scoparium* and *Geotrichum candidum* have been reported to cause considerable loss of the vitamin C contents of the host fruits and vegetables.

Deterioration in the ascorbic acid contents in guava fruits due to infection by *Aspergillus niger*, *Phomopsis destructum* and *Phoma psidii* was observed to be 87.5, 75.4 and 58.6 per cent respectively. Loss in the quantity of this vitamin has also been observed in healthy tissues adjacent to the infected regions.

Deterioration of vitamin C in pathogensis may be due to production of some ascorbic acid degenerating enzymes either by the fungus alone or by the host-pathogen complex. The loss may be due to increased respiration in the diseased tissue and this may induce increased oxidation.

Vitamin C is easily destroyed by cooking, for it is readily oxidised. High temperature causes loss in vitamin C of storage fruits and vegetables. Storage of fruits and vegetables stores at low temperature reduces the destruction of ascorbic acid.

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Advantages of eucalyptus growing

AFFORESTATION is the need of the hour. Senseless felling of trees has caused all round misery to man. Soil has been exposed to erosion, moisture is lost from the soils quickly, climate is getting warmer and rains scanter. There are reasons to believe that desert area in the world is on increase as trees are disappearing.

There are no two opinions about the necessity of growing more trees in India. But what are the good trees that should be grown? Eucalyptus offers many advantages to man and his environment.

Recent researches done at Forest Research Institute, Dehra Dun show that there are three advantages of growing Eucalyptus in India.

1. Eucalyptus consumes less water and gives more dry matter. Scientists at F.R.I. have found that in the juvenile stage, *Eucalyptus citriodora*, *Dalbergia latifolia*, *Pinus roxburghii* and *Populus casale* seedlings consume 16,579/5,526; 4,570/1,143; 1,872/936 and 8,112/2,704 mm of water respectively. Though the consumption of water by Eucalyptus was higher, water consumed per unit gram of dry matter was least by Eucalyptus, i.e., 1.41 mm per gram of dry matter as against 2.59 mm for *Dalbergia latifolia*, 3.04 mm for *Populus casale* and 8.87 mm for *Pinus roxburghii*.

This is very important from production point of view as Eucalyptus consumes least water with maximum production.

2. Eucalyptus causes less loss of rainfall due to interception than many other trees. Investigations carried out on interception of rainfall by an 8 year old plantation of Eucalyptus hybrid have indicated that the rainfall lost by interception was only 11.56 per cent even with high stand density of growth.

The interception loss is lower as compared to indigenous species like *Shorea robusta* (25.3%), *Alstonia scholaris* (26.0%) and *Pinus roxburghii* (22.1%) with comparable densities. Rainfall availability to the soil through the canopy of Eucalyptus plantation is much higher than by any native species.

3. Eucalyptus induces physical changes in the soil to make it more fertile than other trees. Studies on the soils under Eucalyptus in Sal area have revealed that humification (breakdown of organic matter) is faster and easier in these soils. Consequently, the mode of change of physical characteristics of these soils is effective for nutrient recycling.

Heterosis

WE do not know whether our ancestors were scientists in the modern sense of the term, but when they forbade marriage between too close relatives and kins they were scientific in outlook. The ill effects of too close inbreeding have been known for a long time. Charles Darwin (1868) believed that natural selection had produced in humans an instinct against incest, because of the higher survival chances of the more vigorous offspring of exogamous matings.

The disadvantages of inbreeding and advantages of cross-breeding in animals, humans and plants, became known in 1716 when the first plant hybrid was described. But the systematic and scientific investigations of plant hybridization (process of hybrid formation) were published by Josef Gottlieb Koelreuter, a German botanist, in 1766 in which he noted among other things 'hybrid vigour' in interspecific crosses of *Nicotiana*, *Dianthus*, *Mirabilis*, *Datura* and other genera. Charles Darwin (1876) studied the effects of self-and cross-pollination in the vegetable kingdom and concluded that in plants cross-fertilization is generally beneficial and self-fertilization injurious.

Though hybrid vigour in plant hybrids was first studied by J.G. Koelreuter, the basic principles of inheritance were known only in 1900 when Mendel's Laws were rediscovered. Then it became known that genetic variance is the expression of genetic variability. It was also realised that crossing (cross-breeding) produces heterozygosis (Aa Bb) in all characters by which the parents differ and inbreeding tends to produce homozygosis (aa bb or AA BB).

The term heterosis (derived from heterozygosis) was coined by George Harrison Shull of Station of Experimental Evolution at Oldspring Harber (U.S.A.) in 1914. He used the term to avoid the implication that hybrid vigour was entirely Mendelian in nature (heterozygosis is entirely Mendelian). The term heterosis is generally used as a synonym of hybrid vigour but heterosis and hybrid vigour have a relationship that exists between the mechanism and its product. Heterosis is the phenomenon which gives its phenotypic expression through hybrid vigour.

What is heterosis ?

A hybrid (also called F_1 hybrid to denote its first filial generation) gets half of the genes from male parent and half from female parent. On theoretical basis, the hybrid should exhibit medium performance between the two parents. When the vigour of the hybrid is more than mid-parent value $(P_1 + P_2/2)$, or superior (dominant or better) to parent, the existence of hybrid vigour (and hence heterosis) is obvious. It is customary to express hybrid vigour in percentage. The heterosis can be expressed by any of the following formulae:

1. Heterosis = $\frac{F_1}{(P_1 + P_2)/2} \times 100$
2. Heterosis = $\frac{F_1-(P_1 + P_2)/2}{P_1 + P_2)/2} \times 100$
3. Heterosis $\frac{F_1\text{—Better parent}}{\text{Better parent}} \times 100$

Theories of heterosis

Though the occurrence of heterosis is a common feature and has been known for a long time, there is no agreed reason why heterosis occurs. Several theories have been put forward from time to time to explain the mechanism of heterosis.

Cytoplasmic interaction theory: The American botanist A.F. Shull in 1912 attributed hybrid vigour to a stimulus from the interaction of a changed nucleus and a relatively unaltered cytoplasm. (In the process of hybridization the cytoplasm inherits through female parent and remains unchanged, while the nucleus changes by taking half of the genes from the male parent). The effects of cytoplasm on several plant characters have been known and the heritable changes due to the so-called 'plasma genes' (cytoplasmic genes, i.e., DNA which is present in the cytoplasm of the cell and cytoplasmic organelles which are responsible for cytoplasmic inheritance) are also known.

Dominance theory: A.B. Bruce of U.S.A. in 1910 proposed the dominance theory. This theory states that hybrid vigour results from the interaction of favourable dominant or partially dominant genes which are assembled in the hybrid from the two parents.

$$\begin{array}{ccc} \text{Parent I} & \times & \text{Parent II} \\ \text{(aa bb CC} & \Big\downarrow & \text{(AA BB cc} \\ \text{dd EE)} & & \text{DD ee)} \\ & \text{hybrid} & \\ & \text{(Aa Bb Cc Dd Ee)} & \end{array}$$

D.F. Jones of Connecticut Agricultural Experiment Station, U.S.A. in 1917 favoured Bruce's theory and added the linkage concept. Linked favourable dominant or partially dominant genes are responsible for vigour of the hybrid.

Overdominance theory: The concept of stimulating effect of hybridization was developed independently by G. H. Shull (1908, 1911) and Edward M. East (1908) of Connecticut Agricultural Experiment Station, U.S.A. According to this concept, a heterozygote (Aa) would be better than homozygote (aa or AA). One of the explanations of this theory is that the hybrids exhibit overdominance due to cumulative action of divergent allelic genes.

Physiological stimulus theory. E. M. East (1908) and G. H. Shull (1908-1914) emphasized that heretozygosity was the basic cause of heterosis. They believed that the two allelic (divergent) genes present in the hybrid provided some sort of physiological stimulus to the hybrid which resulted in the enlarged size of the vegetative characters and higher yield.

Initial capital theory. The work of E. Ashby and his co-workers (1930-1936) in U.S.A. emphasized that hybrids have increased rate of growth during early stages of development and their embryos attain larger size. This theory believes that the initial capital of the hybrid embryo ultimately results in the expression of heterosis.

Complimentary gene action theory. Several characters such as height, growth, yield, etc. are not governed by a single gene but by the combined (complimentary) action of several intermediate characters (genes). Lack of or poor potential of even one intermediate character can influence the final product. Let us assume that the yield character of a plant is influenced by six intermediate characters A, B, C, D, E and F. If the C character is represented by less efficient C′ in one parent (A) and E by E′ in other parent (B), then both the parents would have poor yield, but a hybrid between these two parents would show vigour over the two parents. This concept has gained support from the recent analysis of heterosis by S. K. Sinha and Renu Khanna (1975) of the Indian Agricultural Research Institute, New Delhi.

Balanced metabolism theory: William J. Robins (1952) of the Columbia University (U.S.A.) analysed the parents and hybrids for various growth factors such as vitamins and growth regulators and found that usually the parents were poor in one or two factors but the hybrids were normal in composition. This theory believes that vitamins and enzymes neither in shortage nor in excess are beneficial to plant. Only in balanced form they are effective.

Utilization of heterosis

With the development of heteros is it conceptwas postulated that the F_1 crosses probably would beof commercial value in some crops where crossing was easy, such as eggplants, tomatoes, pumpkins and sugarbeets. Today, the use of heterosis in practical plant and animal improvement has surpassed earlier predictions.

Table 1 lists some plants and animals where heterosis has been exploited on commercial basis.

Table 1

Farm crops :	Maize, sugarbeets, sorghum, pearl millet, wheat, barley, paddy.
Forage crops :	Forage sorghum, alfaalfa, and grasses.
Vegetable and horticultural crops :	Tomatoes, onions, spinach, carrot, cauliflower, cabbage, eggplant, sunflower and annual ornamentals.
Fruit crops :	Squashes, watermelons, muskmelons, coconuts.
Livestock :	Swine, poultry, beef, and milk cattle.

Methods of breeding for heterosis

Choice of the parent. It should be emphasized that sometimes the hybrids show negative heterosis (they are inferior to parents). It is actually the complementation between the parents which is important for expressing hybrid vigour. For the production of good hybrids, the choice of parents should be based on genetic diversity related to productivity and adaptability. The components of heterosis and their relation to the diversity between parents are of great importance. Therefore, the selection of the specific plant type for increasing yield (or other agronomic characters) should be carried out by measuring the relative performance of plants through diallel crossing system, a system in which all possible crosses are made and studied.

Hybridization: All methods of hybridization in plants are based on the principle of transference of pollen from one parent to the stigma of the other parent. Depending upon the nature of flower (self-pollinated or cross-pollinated), the methods of hybridization are different in different crops. In self-pollinated crops the plants are first emasculated (male organs are removed) and then pollinated with the desired parent. In cross-pollinated plants the desired parental plants are sown near each other and emasculated only to eliminate the chances of self-pollination. Cytoplasmic male sterility (the specialized condition of the bisexual flower which contains non-functional male parts, hence functions as female) has opened up a new era in the history of plant breeding. It is being extensively used for hybrid seed production now a days.

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Lysosome—digestive body in the cell

WITH the help of electron microscope and the cyto-/biochemical techniques, the various cellular components have been recognised and their functions studied in detail. The structures known as lysosomes were first called pericanalicular dense bodies, a name that suggests their location but not their function. Their function, until recently, was quite unknown. In 1955, Christian de Duve and his colleagues at the Catholic University of Louvain renamed these bodies as lysosomes because they contain digestive enzymes capable of lysis, that is, digestion. The exact cytoplasmic origin of lysosome is not yet clear. However, it has been suggested that they are formed in association with the Golgi apparatus or endoplasmic reticulum.

Structure

Lysosomes usually appear as dense bodies surrounded by a membrane. Their shape and density vary broadly, but most of them are between 0.25 micron to 0.50 micron in size. Lysosomes contain more than a dozen enzymes including ribonuclease which act on ribonucleic acid, deoxyribonuclease for hydrolysing deoxyribonucleic acid, phosphatase to break phosphate esters, cathepsins to digest proteins, glycosidase for polysaccharide and glycosides and sulfatase to split sulfate esters. All these lysosomal enzymes are enclosed within a membrane.

Depending upon their digestive activity, the lysosomes can be characterized as follows ; (i) the storage granule (primary lysosome) with a relatively homogeneous content and a peripheral localization of enzyme, (ii) the digestive vacuole with a heterogeneous or frothy content and a random distribution of enzymes (secondary lysosome), (iii) the autophagic vacuole with mitochondria or endoplasmic reticulum in the process of degeneration and a randomly distributed enzyme, and (iv) the residual body containing myelin-like bodies and a peripheral distribution of enzymes.

Function

The simplest and most obvious role of a packet of digestive enzymes within a cell is in necrosis and autolysis, the death and self-dissolution of tissues respectively. The membrane of the primary lysosome simply dissolves liberating the enzymes which dissolve the cell. This can follow wounding or other damage to tissue or it can take place naturally in the course of development, i.e., in the ovary after degeneration of corpus luteum and in a tadpole when it loses its tail. In a tissue, or an organ isolated from body the lysosomal enzymes are released in the cell which break down rapidly the large molecules such as proteins, lipids, nucleic acids and carbohydrates. It has been established that the concentration of lysosomal enzymes in the tail of an amphibian increases before metamorphosis. The concentration of these enzymes, which act as catalysts and are not consumed in the process of tissue digestion, increases as the tail is resorbed. Lysosomal enzymes play their role in these processes in three different modes: (i) White cells and other scavenger cells invariably invade the areas where cell destruction occurs by the action of lysosomal enzymes inside them. (ii) Autophagy: portions of a cell somehow find their way into the cell's own lysosomes and are broken down. How the self-engulfment of the cell fragments takes place is now known. During starvation, this process apparently enables the cells to use part of their own substances as fuel and for the renewal of essential constituents without doing themselves irrepairable damage. As in normal endocytosis, autophagy remains localized by the limiting membrane. (iii) By rupture of the lysosome membrane inside the cell and the digestion of the latter by the released enzymes. It can be described as a perforation of the cellular digestive tract. Such ruptures take place fairly quickly in dead cells in a manner that recalls the rapid postmortem purification of the digestive mucosa of higher animals. It is obvious that once repair mechanisms are interrupted the areas most dissoluted will be those immediately adjacent to destructive enzymes. In the normal life processes of multicellular organisms lysosome rupture, following the death of a cell, may have some value as a built-in mechanism for the self removal of dead cells.

However, can a cell discharge lysosomal enzymes to destroy surrounding structure? Apparently by reverse phagocytosis a packet of enzymes from a lysosome is released outside the cell where it digests contiguous structures. This is how a sperm penetrates the protective coating of the ovum. It also explains how osteoblasts, the cells that destroy bone, act and the ability of white blood cells to pass quickly out of the blood vessels into the tissue spaces at the site of an infection.

In multicellular animals there are generally three stages involved in the series of reactions by which complex foodstuffs are utilized. Firstly, digestion takes place in the digestive tract. Digestion may be defined as the process of converting complex food into simple products which the individual cells can use for their metabolic needs. In this way, the complex molecules of carbohydrate, fat and protein are split into glucose, fatty acids and amino acids respectively. The basic reaction involves the addition of water and, therefore, is called hydrolysis. Enzymes which participate in these reactions are called hydrolases. There are specicfi hydrolases for each substrate. Secondly, further degradation of the end products of hydrolysis occurs exclusively within the cell and involves glycolysis, fatty acid oxidation and deamination (for details see *Text Book of Physiology and Biochemistry* by G. H. Bell, J. N. Davidson and H. Scarborough E.L.B.S. edition, 1970). By these processes the end products of digestion are converted into acetyle coenzyme A, alpha-ketoglutaric acid and oxaloacetic acid. These, in turn, enter the third and final stage referred to as the citric acid cycle or the Krebs' cycle. This stage takes place within the mitochondria and involves reactions by which energy is made available or stored in the form of adenosine triphosphate (ATP).

In lower forms, which do not have digestive tract, much depends upon intracellular digestion of the large molecules; there is a mechanism for intracellular digestion of the large molecules which are taken into the cell by the process called phagocytosis. Recently, a new term endocytosis has won favour. As the cell engulfs the particle and forms invagination, the latter is pinched off from the cell membrane to become an internal sac or body. It is referred to as a phagosome. The phagosome moves towards the primary lysosome. The two bodies come into contact and their membranes fuse, to form one body, the secondary lysosome. The enzymes from the lysosome come into contact with the molecules brought into the cell in the phagosome, and thus the digestion occurs. Once the molecules are degraded sufficiently, the smaller products can diffuse out of the secondary lysosome, also called digestive vacuole. Within the cell the steps described are carried out, and ultimately ATP is formed in the mitochondria. In the digestive tract there remain residues that must be eliminated by defecation. The residues left in the digestive vacuole are also eliminated. The vacuole now moves on to the cell membrane where reverse phagocytosis occurs.

For this primitive intracellular digestive tract to continue to function there must be lysosome production at a rate equal to that of the endocytosis. Practically little is known concerning the formation of lysosome, or the factors that control the rate of formation. The digestion of bacteria by leukocytes is an important form of defense against diseases. Not surprisingly, bacteria have developed adaptations that enable them to survive lysosomal attack. Several bacteria elaborate poisons that kill leukocytes before the bacteria are themselves destroyed; others, including those causing tuberculosis have thick waxy coats that resist attack by enzymes. There are some rare inherited diseases in which the lysosomal system is ineffective. In the Chediak-Higashi syndrome, one of the inheritable diseases in man caused by chromosomal abnormalities (the children develop malignant disease of the spleen and lymph gland), the lysosomal granules are abnormally large. The ingested bacteria are not killed. In another disease, the enzyme leukocyte oxidase is inactive: bacteria or viruses are phagocytized but are not digested in the usual manner. In much the same way, the inactivity of individual lysosomal enzymes may be responsible for certain 'storage' diseases in which a metabolic product is not broken down. It accumulates in a pathological quantity.

Lysosome and disease

Most of the lysosomal disease processes investigated so far involve situations in which the untimely rupture of the lysosomal membrane leads to some form of cell damage. A. Allison and his associates (1967) at the National Institute for Medical Research, London have studied the effects of small particles of silica, asbestos and other substances on cells. The effects were not only diseases such as silicosis and asbestosis but also gout and inflammation in general. The fact that exposure to asbestos particles is associated with the development of some kinds of cancer also provides links between lysosomes and carcinogenesis.

Most foreign particles such as carbon taken into the lungs by inhalation of smoke-polluted air remain for years within phagocytic cells and are innocuous. However, certain inhaled particles, including several crystalline forms of silica (silicon dioxide), stimulate a severe reaction in the lungs. The deposition of fibrous tissue can lead to marked impairment of lung function.

Prolonged exposure to asbestos dust leads to asbestosis, a disease like silicosis, which is associated with the deposition of fibrous tissue in the lungs. In 1960, C. J. Wagner and his associates of South Africa found the development of malignant tumors in asbestos workers. Similar tumors are found in animals that have been injected with asbestos particles in the chest cavity. Electron microscope and other studies show that asbestos particles are taken up into lysosomes, from where some of them escape later. Wagner also found that injections of silica particles into the thoracic cavity of rats lead to malignant tumors of the thymus gland.

Effects of drugs on lysosome

The precise effects of some drugs on the lysosomal membrane are known. Cortisone and related corticosteroids, for example, stabilize the membrane making it less liable to rupture. A number of steroids and other compounds weaken the membrane making it more permeable. One such compound is carbon tetrachloride which is used against certain worms that parasitize on the intestines of mammals. The digestive tract of these worms is a tube of amoeboid cells, each of which ingests food and breaks it down within lysosome. Small doses of carbon tetrachloride damage the worm-cell lysosomes and the massive release of hydrolytic enzymes kills the worms. High doses of vitamin A also bring about the release of large amounts of lysosomal enzymes.

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Why mosquitoes prefer attacking women

THERE is an unambiguous scientific proof that women are preferentially bitten by mosquitoes; and that men are comparatively immune to them. It will always be a bitter experience for a woman sitting with a man in a room, to find that she is bitten either exclusively or at first, and the insect may or may not touch the man.

Researches in Canada and Germany in the last decade have established categorically a close relationship between mosquitoes, malaria, and women. Speaking at the annual meeting of the New Jersey Mosquito Extermination Association in 1963, Prof. P. Roesslar of the Western Ontario University (Canada) said that estrogens—the female steroidal sex hormones—act as strong attractants for mosquitoes. Besides being present in their reproductive system, estrogens are also found in the perspiration of females. Two types of estrogens have been found on the skin surface of women: 17-hydroxy steroids and 17-keto steroids. Of the former type, "oestriol" (estriol) hormone was described to be the most effective attractant for mosquitoes. As little as 10^{-9} μg (1/1000,000,000 microgram) quantity of oestriol, when evaporated from the skin surface of a woman, can attract a mosquito. The 17-keto steroids (for example, "oestrone" hormone) also act more or less in the same way.

Prof. K. Bosse and his associates at Munich University, in 1964, prepared skin surface extracts from 175 women and estimated the concentration of 17-keto steroids present in them. The highest concentration of the hormones was found on 1st-4th, 9th-12th, 17th-20th, and 21st-24th day of the menstrual cycle. During these periods the women undergoing tests were frequently attacked by mosquitoes.

Whereas the concentration of 17-ketosteroids in the perspiration of men was found to be more than 74 microgram per cent, that found in women was more than 423 microgram per cent. The all time maximum hormone quantity on the skin surface of women was observed between 17th-20th day of menstruation.

Prof. Bosse further observed that certain amino acids such as tyrosine, glutamic acid, aspartic acid, serine, threonine, proline, and histidine also possess attraction for mosquitoes. The perspiration of men and women also carries these and other amino acids. The results of estimation of amino acid content of perspiration in different persons have revealed that their quantity varies from person to person, indicating the severity of mosquito attack. If an individual (man or woman) has a higher content of these amino acids as compared to another person, the former will become more susceptible to attack by mosquitoes.

In view of the above observations it becomes desirable on the part of the women to adopt anti-mosquito measures, especially on the specified dates of menstrual cycle, in order to save themselves from malaria.

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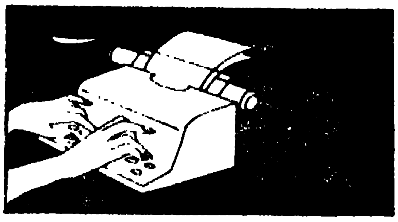
Carbon granules produced

CRUSH the anthracite coal to a suitable size and seive through suitable size mesh to get particles of 225 μ. Baking at a temperature above 1000°C in inert atmosphere, oxidation treatment for a suitable period of time and at a suitable temperature in the presence of air or CO_2, and other steps follow afterwards. The material is finally seived and bottled. This is briefly what P. T. John and K. K. Datta of the Materials Division of National Physical Laboratory, New Delhi, describe as the process developed by them for manufacturing carbon granules for use in telephone transmitters. In our country, presently the requirements of carbon granules for the above mentioned purpose are completely met through imports. With an annual present consumption of about 4000 kg, demand for carbon granules is likely to increase with the expected increased demand and supply of telephones in the near future.

Telephone transmitters or microphones are a class of transducers which act as the interface between a listener and the transmission system and are "among the most essential components of the telecommunication system." As John and Datta put it "there are many types of microphone with different principles. But the type that employs the use of fine carbon granules is more common due to its robustness, high sensitivity and low cost". Exactly, of what use these carbon granules are in a telephone transmitter? A carbon microphone consists of two carbon electrodes fitted in a chamber whose walls are well insulated by a paint. In between the electrodes are filled up the carbon granules. Out of these two electrodes, one is fixed while the other one can move—the latter being attached to the diaphragm. While speaking into the microphone, sound waves falling upon the diaphragm make it to vibrate causing carbon granules to move in resonance with the diaphragm. The compressions and rarefaction in granules cause variations in the current passing through them from one electrode to the other; the variation in current finally passes through the telephone wire.

The carbon granules produced at National Physical Laboratory have been tested by Indian Telephone Industries, Bangalore, and found satisfactory and comparable to the imported ones.

Zaka Imam



NEWS & NOTES

Indian Science Congress—1977

DR. H. N. Sethna, President of the Indian Science Congress Association introduced the focal theme in his presidential address. He appealed to developing countries to join hands for protecting their raw materials which he said are being exploited by developed nations and their transnational corporations. He called for regional economies, more "investment in man" and advocated the use of remote sensing and satellite technology for better and rational utilization of India's natural resources.

It was perhaps one of the dullest Science Congress sessions. The Calcutta cricket test match was on the minds of many participants and many paper reading sessions were thinly attended. The medical and veterinary sections wound up on the third day and the popular lectures, except two, were neither popular nor interesting. Dr. A. G. Jhingran, Director of the Central Inland Fisheries Institute (CIFRI) in Cuttack gave an excellent popular lecture on fish resources in India, the great potential for fishing in the continental shelf, the glass jar hatchery and the induced breeding with pituitary extract methods developed at CIFRI. Cyril Ponnemperuma of the University of Maryland gave a popular lecture on the oft-repeated subject of Mars and the Viking mission and concluded by saying that the Vikings found no evidence of life on Mars.

One of the report read was the distressing finding by scientists of the Anthropological Survey of India that Indians are adapting to malnutrition by becoming smaller in size. Some 60 population groups have been studied for two generations and 43 of them have become shorter in varying degrees. Another project of ASI has confirmed that Indians are losing weight. Dr. Ganguly said that diminution in height and weight of Indians could be the result of the process of adaptation to malnutrition.

In his presidential address to the section on "Zoology, Entomology and Fisheries," Prof. P. N. Srivastava, Dean of the School of Life Sciences at the Jawaharlal Nehru University exposed some of the side effects of administering radioisotopes to pregnant women. The use of Iodine-131 and P-32 has been widespread but according to Dr. Srivastava very little is known about their adverse effects.

In a symposium on the "Mechanism of sleep" in the physiology section, Dr. H. S. Narayanan revealed the first recorded case of "hypersomnia." in India. He said the 21-year old male patient had the habit of sleeping for four days in a stretch. If disturbed in sleep he would become restless and demand a lot of food like the mythical Kumbakarna of the epic Ramayana who slept for six months and ate voraciously when woken up. According to Dr. Narayanan, hypersomnia is an extremely rare phenomenon and only 11 cases are recorded so far in the world. Dr. Narayanan is working at the National Institute of Mental Health and Neurological Sciences in Bangalore.

Some of the developments on research in Indian Medicine were conveyed through an exhibition organized by the Central Council for Research in Indian Medicine (CCRIM). One significant finding was that L-dopa, the only known drug for Parkinson syndrome, could be produced from the plant *Mucuna pruvrita.*

A new nematode parasite that causes havoc to bananas was reported in a paper by Dr. R. S. Tandon and Dr. Parveen Kumar from Lucknow. They said roots of the plant *Musa paridisiaea* were heavily infested with the nematode "pratylenchus."

The beneficial effect of orange juice in reducing the severity of rubella virus infection (german measles) was highlighted by an Indian doctor from the University of Florida. (USA). She said that a controlled study was done on 55 volunteers who were challenged by the virus through the nasal route. The severity of the infection was found to be reduced in those who were given 250 ml of orange juice four times a day. The antibodies against the infection also appeared much sooner in the orange juice group compared to the group that did not receive orange juice. She said that several substances in orange juice, and not vitamin C alone, were probably responsible for altering the course of German measles.

Prof. W. H. McCrea, the British astronomer, gave an account of the possible effect of the galactic structure on the solar system. According to him the ice ages occur probably because the solar system is accreting interstellar dust as it moves across the dust-laden inner limb of the spiral arms of our galaxy. It takes the sun about 250 million years to go round the centre of the galaxy during which it crosses twice the dust limbs of the two spiral arms. During its lifetime the sun has made about 50 orbits around the centre of the galaxy and has accreted billion billion tonnes of dust. Prof. McCrea said that accretion of dust would cause a slight increase in the solar emission enough to advance ice age. He said that right now the sun had crossed the dust limb and entered the spiral arm. It would take some ten million years for the sun to cross the width of the spiral and this period may be critical for the earth and the solar system. An ice age may come as the solar system is moving within the arm and it is likely that the sun and its planets would come close enough (30 light years) to a supernova that will remove the ozone cover on earth and destroy life. The chances of sun's encounter with a supernova are high in the next ten million years because the sun is right now in the midst of the spiral arm—the region where most supernova explosions are known to occur.

In the Botany Section, Prof. K. K. Nanda of the Punjab University reported success in propagating many forest trees from stem cuttings. Out of 155 tree species examined, more than 100 species were found incapable of vegetative reproduction. But Prof. Nanda said that with the use of regulatory substances such as gibberelins and phenolic compounds, it was possible to induce root formation from stems of these "reluctant" species. Since trees grown vegetatively are of "pure types", and can be multiplied rapidly, the research has considerable potential in breeding and tree plantation programmes. One immediate application of this work is in growing teak (*Tectona grandis*) from stem cuttings. Many horticultural plants hitherto grown from seeds can be grown from stems using nutrients and growth regulators. Trees that do not grow uniformly in all seasons (poplar trees, salix and shoe flower) can now be induced to grow in and out of season using regulatory substances, Dr. Nanda said. He said work is now in progress for vegetative reproduction of trees like *Pinus longifolia* (chil) and *Cedrus deodara* (deodar) used in house construction and furniture making.

On the final day of the Science Congress, ISCA President Dr. Sethna announced several recommendations on the focal theme. Among the general recommendations were : (1) application of statistics in various resource areas; (2) longterm planning for continuous updating of information on survey of natural resources; and (3) utilisation of aerial and satellite methodology for the assessment of resources.

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Science paper reading contest

THERE is much talk about scientific temper in the country. But, the other day, on December 6, 1976, when I attended the All India Science Paper Reading Contest organised by the Physics Society, St. Stephen's College, I was at a loss to find the temper lacking even among our science community, the students and teachers. Only a few local colleges took part in this competition and the size of audience was below expectation. Only a few participants, mostly those who were expecting prizes, remained glued to their seats till the end, while others, after taking the lunch, left the scene. Teachers, it was sad to see, were mostly those of the college, as if for the rest the contest was an alien, non-academic phenomenon. So much scientific temper, one can imagine, is in our temples of learning, what to say of the entire country!

The Science Paper Contest which, as claimed by the organisers is only one of its kind in the country, was on the whole well organised. In all 15 minutes were given to each participant, five for reading the paper, five for drawing figures, etc., and five for question-answers and discussion. The subjects on which papers were read were varied, but as expected certainly not on the most talked about. For instance, except Genetic code, Space science, students read papers on Anti-worlds, colour in plants, scientific progress, superconductivity, resistivity in solids.

Utpal Banerjee of Chemistry Honours, St. Stephen's College, was unanimously selected the best contestant and was awarded the first prize. His was not 'paper reading' affair but a talk on genetic code. Utpal has in him the making of a popular science lecturer, with such a remarkable ease and clarity he dealt the subject. The second best was Shishir Priyadarshi, also of St. Stephen's College, who talked about the anti-worlds. Though he presented the subject nicely, he was on occasions uncomfortable. M. Chandrasekhar, who won the team trophy for Kirori Mal College, talked about the 'Colour in plants' and his presentation was also fairly good. One peculiar instance was of Miss Vatsala Chana of Miranda House College who though read nicely, had selected the subject' 'The limitation of scientific progress' which was difficult. She went on talking about pollution and pesticidal problems, which have not scientific advancement (the srindered latter has a bit but she couldn't strike the nail on the head) but have led us to look for alternative means of tackling them.

Some issues I wish to comment on: The judges shouldn't show what they think of a contestant publicly. There is no need of asking too many questions when one or two 'insight' questions could serve the purpose in judging whether the contestant knows the subject or not.

A bit of so-called 'leg pulling' can dissuade many a young people from entering such contests again. It is better to call the contest 'Popular lecture', changing its purpose and making it more meaningful, as I found many participants reading out papers in a monotonous manner. The topics selected for such a contest should have a popular bias, should be topical so that more students would like to sit through—classrooms are enough for details and technical stuff given in textbooks. Scientific temper needs much purposeful financing of the scientific activities. The need is to start from schools and colleges only, where the receptors for scientific wonders are maximum: In short, it is a matter of popularising science in form of popular lectures, extracurricular activities, films, etc, on a large scale.

DILIP M. SALWI

Efficacy of chemical pesticides is declining

AFTER three years of studies, a Committee of the U.S. National Academy of Sciences headed by Dr. Donald Kennedy of Stanford University and composed of about 60 specialists in various aspects of pesticide use and hazard recently concluded that the efficacy of chemical insect control is declining alarmingly and hence the U.S.A. might have difficulty in achieving increased food production. Because many insect species have apparently developed some genetic resistance to insecticides, the Committee recommended the making of a new generation of insecticides that would be designed more efficiently to harm their targets. The Committee also recommended that alternative method should be developed to supplant chemical insecticides and suggested that biological weapons such as viruses and microorganisms should be used against insects. The Committee listed many factors that contributed to the loss of chemical control of important insect pests. Some of these are the appearance of genetic resistance to the chemicals in many pest species, breakdown of natural control mechanisms, sometimes chemicals also killing the insects' natural enemies, and strict regulation or ban of use of insecticides from public concern over hazards to environment and human health. The young American adults probably consume about 40 milligrams of chemical insecticides a year in food and carry about 100 milligrams permanently in their body tissues. As a measure to reduce this hazard, the Committee recommended compulsory reporting to the government of production and use data of insecticides. The contemporary pest control based primarily on chemicals had been one of the main factors in the high yields of the U.S. agriculture. On the other hand, the great reliance on chemicals often led to increases in crop-destroying pests or causing health hazards by producing pesticide-resistant insects that harbour diseases, the Committee pointed out.

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Nobel Laureate Lars Onsager passes away

IN the death of Lars Onsager, who won the 1968 Nobel Prize for chemistry, on the night of October 5/6 due to heart attack, the world has lost perhaps the greatest theoretical chemist of the century.

Born in Oslo, Norway on Nov. 27, 1903 Onsager did not really have very good schooling but he showed the markings of a genius quite early. Thus at school, he had jumped a grade and in the tradition of other great geniuses of this century (Einstein, Bohr, Heisenberg and others), he had done his Nobel-winning work in his twenties and had presented the same at a Scandinavian scientific meeting in Copenhagen at the age of 26. Two years later (1931), and four years before obtaining his Ph.D., he published his work in final form in two papers in *Physical Review*. So elegant was the presentation of the papers that they extended only to 22 and 15 pages, one of the briefest to win a Nobel Prize. Onsager's work was so far ahead of his time that it literally went unnoticed for a quarter of a century.

While the three laws of thermodynamics are based on a very sound footing, they are not adequate in dealing with many of the natural processes, which are irreversible e.g. dissolution of a lump of sugar and its diffusion throughout a cup of tea. Onsager's reciprocal relations represent the fourth law of thermodynamics which deals specifically with irreversible processes and describes them adequately. In the words of Professor S. Claessen, who delivered the presentation speech at the Nobel Award ceremony in 1968, "The proof of the reciprocal relations was brilliant."

Onsager was a truly multifaceted genius who made very significant contributions in diverse fields as colloids, dielectrics, order-disorder transitions, metals and superfluids, hydrodynamics and fractionation theory. He is also famous for his work on the theory of strong electrolytes, the solution of the Ising problem and quantization of vortices in liquid helium.

No wonder, he was honoured very widely. A host of universities including Harvard, Brown, University of Chicago, etc. conferred honrary doctrates on him. He was awarded many medals including the Rumford Medal of the American Academy of Arts & Sciences, the Lorentz Medal from the Royal Netherlands Academy of Sciences, the Peter Debye Award of the American Chemical Society, etc. Professor Onsager was a member of many learned societies.

After obtaining his Ph.D. from Yale University in 1935 on the mathematical treatment of deviations from Ohm's law in weak electrolytes, he taught at his *alma mater* upto 1972, having been elevated to the post of J. W. Willard Professor of Theoretical Chemistry in 1945. At the time of his death, Professor Onsager was working at the Centre for Theoretical Studies of the University of Miami in the United States.

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Symposium on plasma physics and MHD

A symposium on Plasma Physics and Magnetohydrodynamics is being organised at the Plasma Physics Section, Bhabha Atomic Research Centre, Trombay, Bombay-400085 from February 21 to February 23, 1977.

For more information, write to
Dr. V. K. Rohatgi, Convener,
Symposium Committee, Plasma Physics Section, Bhabha Atomic Research Centre, Trombay,
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MEDICAL NOTES

Fingerprints may expose heart trouble

FINGERPRINTS may provide a clue to a common heart condition that can cause chest pain and irregular heart beats, according to Dr. Mark. H. Swartz of Mount Sinai Hospital. He said the finding may help doctors spot persons with the problem, called mitral valve prolapse, in which a heart valve fails to close properly, so allowing the blood to flow in the wrong direction. Swartz told an American Heart Association meeting that he found some persons with the valve defect had abnormally high numbers of arching patterns in their fingerprints. An arch is made up of gently curving ridges from one side of the finger to the other without the much more common looping or whorling patterns.

Swartz and his associates thought of looking at fingerprints to see if there was an association with the valve problem because there has been speculation that the defect is inherited. The heart is formed during the third and eighth weeks of pregnancy and fingerprint patterns are initiated during the sixth week. Other heart irregularities and other diseases also have been linked to fingerprints. He speculated some genetic or environmental factor may be responsible for the problem. It interferes with the orderly fetal development of the mitral valve and at the same time interferes with the fingerprints patterns. He says that mitral valve prolapse may exist in as high as 6% to 10% of the general population and the condition is more common in women including many in their twenties. Its symptoms include chest pain, irregular heart rhythms, light headedness and fainting. The condition was first detected in 1887, but was not looked at in any depth by doctors until about 10 years ago. Doctors often missed the condition. The condition is difficult to treat although, drugs do relieve the symptoms to some extent.

R. RAGHUNATHAN
Nashville, Tennesse (USA)

Propranolol curbs hazards of cocaine overdose

A valuable heart drug is finding a new life saving use in treating people overdosed with cocaine. The drug 'propranolol' quickly brings galloping blood pressure and pulse down to normal range averting the threat of lethal brain strokes or heart failure. It protects against the physical hazards without taking away the euphoria or "high" from cocaine, says Dr. George R. Gay of Mendocine, California, who is a co-author of a report on propranolol in clinical toxicology.

Propranolol is used to control cardiac arrhythmias or erratic heart beats, and in some cases of angina pectoris or heart pain on exertion. Dr. Gay and his associates have now treated more than 50 persons, who in the language of drug users, had sniffed too much cocaine and were "overramped" or "juiced". The drug is a specific antagonist for the overdose reaction, they said.

Citing one instance, they said they were called backstage during a rock music concert and see a young male musician who was "too wired to play". Friends, said he had a lot of coke, had been up all night, and had his last sniff of cocaine a few minutes earlier. The man was pale, nervous, shaking and intermittently retching. His pulse was 140 (normal 70) but thready and weak. His blood pressure was extremely high, at 220 over 160 and was breathing 40 times a minute. Sixty seconds after he was given one milligram of propranolol by vein, his pulse dropped to 120, blood pressure to 200 over 120, and respiration to 32 a minute. Within another 15 minutes, after more doses of propranolol, his pulse was 78, blood pressure a normal 120/70, and respiration 14 a minute.

Propranolol has specific blocking effects to offset the nervous system stimulus of cocaine. It appears absolutely to protect the cocaine abuser from the risks of cardiovascular accident, acute congestive heart failure and cardiac arrythmia. The report is preliminary and more studies are needed under controlled conditions to measure the beneficial effects of the drug.

Cocaine is so popular now that it can be called the "sniffing seventies". He cited Haight Ashbury clinic's figures to show that now about 15% of all drug users had used cocaine within the last 30 days compared with only 2% coming to clinic in 1967. As such, if the validity of the preliminary studies is proved, propranolol will become a potential life saving drug.

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Nashville, Tennesse (USA)

Of stress and tumours

THE influence of physical stress upon various physiological and pathological processes of the body has been the subject of extensive research for past few years. Recently, an interesting addition to the influence of stress in the process of tumour development has been made by a group of American Scientists. Dr. Eli Seifter and his co-workers of Yeshiva University, New York have demonstrated (*Experientia*, vol. 29, 1379, 1973) that physical stress increases the incidence and severity of tumour development in experimental animals. In their study with the mice inoculated with a murine sarcoma virus, muSV-M (a virus that causes connective tissue tumour) they have noticed that excessive and unusual physical stress causes a rapid development of tumour in experimental animals in comparison to the control specimens inoculated with the same virus, but were kept in a peaceful condition away from any sort of unusual physical stress.

It is, however, still a riddle how stress influences the process of tumour growth. It has been hypothesized by Dr. Seifter and others that stress reduces the immunocompetence of an organism through increased adrenocorticosterone secretion and makes an easy growth of tumours. Vermon Riley of Pacific North-West Research Foundation, Washington has added further information regarding the mechanism of immunosuppression and tumour growth in overstressed animals. According to his idea expressed in *Science* (vol. 189, pp. 465, 1975), any sort of unusual stress causes an increase of plasma corticosterone values in blood two to ten times higher than the normal. This abrupt increase of plasma corticosterone value is always accompanied by the involution of the thymus gland and lymphocytopenia. These two latter phenomenon in turn reduce the immunocompetence of an individual and thereby facilitate tumour growth. The idea of Dr. Riley has recently been verified in Dr. Seifter's laboratory by the administration of metyrapone, a chemical that inhibits corticosterone production in blood. In his recent communication (*Science*, vol. 193, 74, 1976), Dr. Seifter has suggested that upon entering the blood stream of tumour bearing animals metyrapone removes typical stress reactions for adrenal hypertrophy and thymus involution and thus makes the individuals resistant to muSV-M infection.

Another agent which is also reported to be effective in preventing virus induced tumour development, is vitamin A. According to Dr. M. Zisblatt and his research team of Yeshiva University, USA repeated administration of vitamin A in tumour bearing mice immediately blocks most of the host responses to stress and prevents thymus involution and immunosuppression within a very short time (*J. Nutr*, vol. 103, 30, 1976). It is, however, quite surprising that vitamin A reacts not only with the muSV-M induced tumours but also with a variety of animal tumours of both virus and non-virus origin. Extensive research is now in progress in different parts of the world to explore various unrevealed aspects of the action of vitamins on cancer and to find out whether vitamins could produce similar fruitful effect on the process of tumour development in human beings.

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SCIENCE FOR THE YOUNG

Tricks of the desert snails

THE molluscs or soft-bodied animals constitute the second largest and most variable group of spineless creatures after arthropoda—the jointed-limbed animals. Rapid spreading capacity and wide range of structural diversity have enabled these slow moving, sluggish creatures to exploit all conceivable habitat on the earth. Though snails in general are inhabitants of moist and cool places such as damp forests, ponds, rivers, lakes, etc., it is not surprising that certain species survive well in arid regions where the conditions are exactly opposite. The most adverse conditions for life in desert consist of a combination of aridity and high temperature. The combination presents a great thermoregulatory challenge to all desert creatures. For the snails, survival at this high temperature poses additional problems; due to extreme water-loving nature they are in constant threat of thermal death, dehydration and shortage of food during long, dry season.

The estimated lethal temperature of snails varies between 50°C to 55°C depending on the species and the time of exposure to heat. But quite often, the temperature of the desert exceeds 55°C even in the shade, particularly during summer. How then does a desert snail keep its body below the surrounding lethal temperature during summer?

A group of scientists led by K. Schmidt-Nielson of the Duke University, U.S.A. studied the thermoregulatory mechanism of a desert snail, *Sphincterochila boissieri*, a species commonly found in the deserts of the near East. In their recent report presented at a symposium on Comparative Physiology of Desert Animals sponsored by the Zoological Society of London in 1971, the scientists have suggested that the snails face the problems in various ways.

Many desert snails, particularly *S. boissieri*, bear an empty space within the shell which forms a sort of air cushion around their soft and moist body. When the snail comes in contact with a hot surface such as a stone or a flint or sunbathed sand, the air cushion insulates the animal against the high surface temperature. Moreover, like many higher animals, the snail remains in a dormant state during extremely hot season. This seasonal dormancy lowers its metabolic activity, reduces oxygen consumption and thereby cuts down the heat production. It is, however, of further interest that unlike other desert forms the snails are restricted in their activity except during the short rainy season when suitable food and drink are easily available. Because of their summer dormancy, the food taken during rainy season is sufficient for long periods. While in dormant state snails can withstand high temperatures, their water loss is reduced so much that their reserve of water is sufficient for survival for several years.

These investigations of Dr. Schmidt-Nielson and other scientists on the physiology of desert animals have revealed that, like many higher forms of life, the desert snails are equipped physiologically to withstand long droughts which may extend even beyond a year.

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Humour in science

WHEN British mathematician Charles Babbage, the man who first thought of computer, read Lord Tennyson's poem "The Vision of Sin", he wrote to the poet: "In your otherwise beautiful poem there is a verse which reads, 'Every moment dies a man, Every moment one is born.' It must be clear that, were this true, the population of the world would be at stand still. In truth, the rate of birth is slightly in excess of that of death. I would suggest that in your next edition of the poem you have it read, 'Every moment dies a man, Every moment one and one-sixteenth is born'.

Strictly speaking this is not correct. The actual figure is a decimal so long that I cannot get it in line, but I believe one and one-sixteenth will be sufficienlty accurate for poetry".

Albert Einstein had once attended the wedding of a young friend. A few years later, the couple brought their eighteen months old son to him. The child looked once at him, and burst into a screaming fit. The embarrassed parents were speechless, but Einstein's eyes lighted up. He patted the boy on the head and crooned, "You are the first person in years who has told me what you really think of me".

Shortly after Enrico Fermi, the Nobel Prize winning atomic scientist, joined the University of Chicago staff, he was told by university executives, "Now that you are undertaking work for the government you undoubtedly will need a stenographer. We will see to it that one reports to you tomorrow". "But", protested Fermi, "I am a physicist not a businessman. What would I do with a stenographer?"

"You must have one" the executives explained, "All important people in this country have stenographers"

"All right", said the scientist, "but in that case I shall need two stenographers—so that they can keep each other busy".

The Mathematician Marc Kac, a Professor at Rockefeller University, had worked closely with many physicists. When he was delivering a lecture at California Institute of Technology some years ago, he was interrupted by Nobel Prize winning physicist Richard P. Feynman who said, "As some of us have been saying, if mathematics had never been invented, the progress of physics would have been delayed by about a week"

Kac fielded the good natured insult with the grace of a sportsman. "Absolutely true," he replied instantly, "By exactly that week in which the Lord God created the universe".

Electrical inventor Nicola Tesla was a brilliant mathematician who constantly looked for problems to solve. In a restaurant, he would not touch his soup until he had first calculated the amount of liquid in the bowl. He enjoyed eating a chunk of steak, but determining its cubic content was even mose fun. One night when he was dining out, a waiter brought him a bowl of fruit salad. Each piece of fruit was of a different size and shape. Tesla's eyes lit up. Here were problems galore —a mathematician's delight. Fifteen minutes later, his pencil was still flying over his pad, covering it with mathematical symbols. The waiter approached and asked, "Is there something wrong with the fruit salad? You have not touched it"

"Wrong? Of course not," replied Tesla, without looking up,"It could not be better".

In the old League of Nations, Julio Casares, a scientist from Spain, had the privilege of sitting on a committee with H.A. Lorentz, the famed physicist, and with his even more famous disciple, Albert Einstein.

The day came when a shrinking budget forced a readjustment in salaries. Since they agreed that the cuts should be proportional to the reduction in funds, it was a simple problem in arithmetic.

Einstein and Lorentz began separately to work out the new figures. Perhaps one used trigonometry and the other differential calculus. But the two scientists came up with results that were not only completely different but totally absurd.

Lorentz, his brows furrowed, stared fixedly at Einstein, who registered complete amazement. Finally both broke into loud, helpless laughter. The conflict was solved by bringing in an accountant, for whom problem of ratio and proportion were a child's play.

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How an electric bell works

THE drum beating and ding-dong of the primitive age have now been replaced by the 'ring' of the electric bells and telephones. This sound has today become the sophisticated way of calling on anyone, whether the place is a house or office or factory. Nevertheless how this pleasing but shrill sound is produced is a mystery to many.

Consider the electric bell shown in Fig. 1. It has a two pole electromagnet ; facing it is a hammer that could strike the gong, producing the metallic sound, 'ring'. There is a contact interrupter attached to the hammer, which also moves in accordance with it, breaking or making the circuit. The circuit, it is clear from the figure, say, begins at push button, through the electromagnet, then through the hammer and contact interrupter , through the source of electricity, and ends with the push button.

When the button is pressed, the electric circuit is complete. Current goes through the electromagnet, to the contact interrupter, and back. As

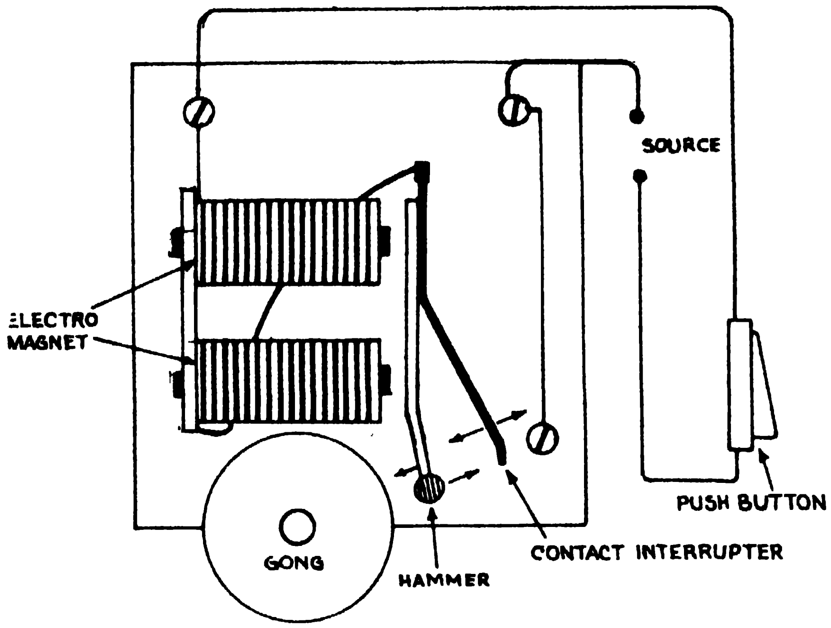

Fig. 1

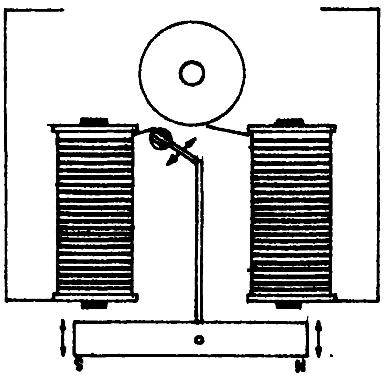

Fig. 2

soon as this happens, the electromagnet acquires the magnetic property and so attracts the hammer. The hammer when pulled stretches the contact interrupter. The circuit, as a result, gets broken. The electromagnet loses its property resulting in the release of hammer. When the hammer jumps back, the contact interrupter also jumps back, and the circuit becomes complete. The electromagnet therefore again attracts the hammer and the process repeats. While the shaft of the hammer hops from electromagnet to the contact interrupter, the other end strikes the gong, producing that metallic shrill sound we call a 'ring'. As long as the button is pressed the bell continues to ring.

In the telephone, there is a different type of bell which produces the less shrilly sound. Shown in Fig. 2, there are two electromagnets and the hammer is itself a magnet. This bell works on alternating current. Depending upon the polarity of the electromagnets, the hammer is attracted by either of them, producing the buzzing sound.

DILIP M SALWI

Books Received

CYTOGENETICS, PLANT BREEDING AND EVOLUTION by U. Sinha and Sunita Sinha *Vikas Publishing House Pvt. Ltd.* 5 Ansari Rood, New Delhi, Pp 319, Rs. 45

FLORA OF HASSAN DISTRICT KARNATAKA, INDIA *by* Cecil J. Saldanha and Dan H. Nicolson, *Amerind Publishing Co. Pvt. Ltd.*, 66, Janpath, New Delhi-110001, Pp. 915, Rs. 75

OPTIMIZATION TECHNIQUES *by* Asghar Husain and Kota Gangiah, *Macmillan Co. of India Ltd.*, 2/10, Ansari Road, New Delhi-110001, Rs. 18, Pp. 317

SCIENCE IN ACTION (Books I-IV) *by* Meera A. Parasnis, *Macmillan Co. of India Ltd.* 2/10 Ansari Road, New Delhi-110001

HUMAN POPULATIONS *by* David Hay, *Penguin Books Ltd.*, Harmondsworth, England, Indian Agents, *Penguin Overseas Ltd.*, 706-Eros Apt, Nehru Place, New Delhi-110024, Pp. 96, £2,75 Net

LADY LUCK : THE THEORY OF PROBABILITY *by* Warren Weaver, *Penguin Books Ltd.*, Harmondsworth, England, Indian Agents : *Penguin Overseas Ltd.*, 706-Eros Apt., Nehru Place, New Delhi 110024, Pp.291, £1.

Science oddities

A PLANT that bursts into flame spontaneously, if the weather gets too hot, seems a figment of an overactive imagination. But *Dictamnus albus*, commonly called fraxinella or gas plant, does just that. On its inflorescence and flower stalks are numerous tiny oil glands which give out a volatile inflammable vapour. When a lighted match is held near, or when the temperature rises very high, this gas ignites and burns with a brilliant blue flame. Some people believe that this is the 'Burning bush of Moses' mentioned in the Bible.

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TEN meters long, with two rows of enormous bony plates on its back, and a grotesquely small head, the ten - ton Stegosaurus was indeed the oddest looking of the Dinosaurs. However, the most peculiar thing about this animal was not its appearance, but the fact that it had two brains—one in the head, and the other in its hip! The brain in the head was tiny, weighing no more than 70 gms. and functioned merely to work the jaws, while the one in the back controlled movements of the legs and tail. Experts are of the opinion that inspite of having two brains, this enormous creature was not even as intelligent as a three-week old kitten!

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THE idea of a steel ball bouncing higher than a rubber ball may sound quite incredible. Yet it is true. This is because the bounce of a substance depends on its elasticity, i.e., its ability to recover its original form or size when stretched or compressed. Though it is hard to believe, steel is one of the most elastic substances, while rubber has rather poor elasticity—though it is easy to stretch or compress, it does not return to its original shape or size accurately.

◆◆ ◆◆ ◆◆

THE only birds in the world that are not guaranteed colour-fast are the African Touracos. They are beautiful birds found in the tree tops in tropical jungles, running nimbly along the branches. Most of the species are crested, and brilliantly coloured in golden green, peacock blue and violet in various combinations, the lovely plumage being set off by crimson wings. This crimson colour is due to a special pigment found in no other bird in the world. When there is a heavy shower, this exclusive pigment is said to dissolve and get washed out by the rain.

◆◆ ◆◆ ◆◆

TO a person on earth the sun appears to be the largest and brightest object in the sky. But actually, the Sun is really a rather small star and only looks so big and bright because it is very near to us. There are stars like *Epsilon Aurigae B* which are estimated to be so vast that the entire solar system upto Saturn could be placed inside them. In fact, we would have to put 27,000 million suns together to make a star of that size. Relatively smaller, but still enormous, is the red giant star, *Antares*, which is 640 million kilometres across, and 290 times as large as the sun.

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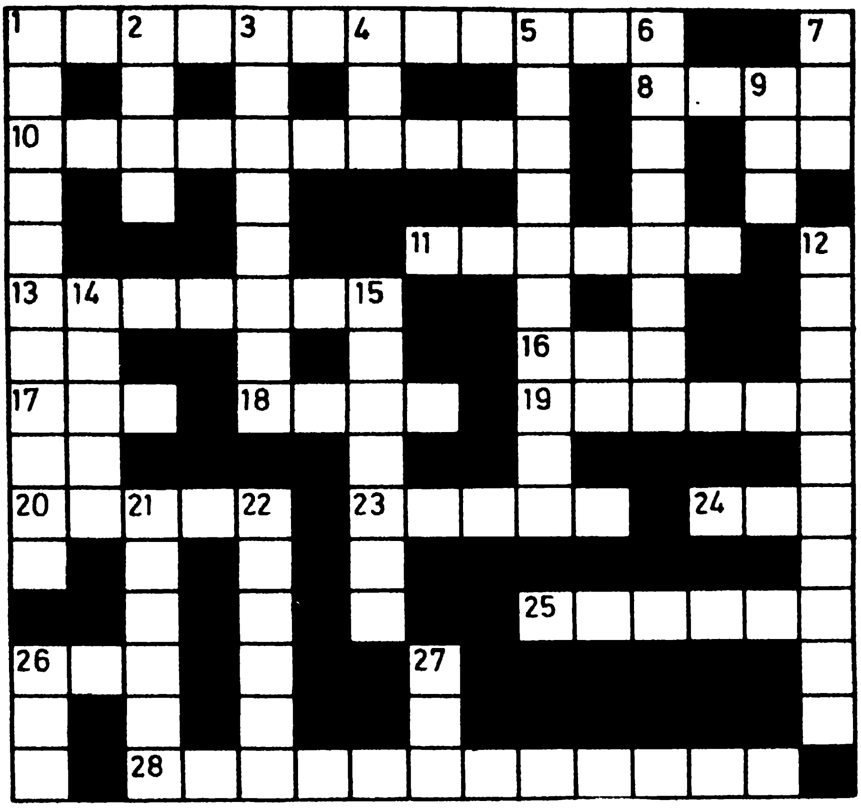
Science Crossword Puzzle



CLUES

Across

1. No bread without it.
8. You hear it, when you speak into a well.
10. A water-soluble vitamin.
11. What active charcoal does in refining of sugar.
13. Regular array of atoms or ions in space.
16. A metal that coats household utensils.
17. A home for wild animals.
18. A gas used in advertising.
19. What a mosquito is :
20. Exuded by some plants.
23. A gas which is a powerful oxidising agent.
24. A protein-rich diet.
25. A fraction obtained from petroleum.
26. A source of metals.
28. An instrument to measure wavelength.

Down

1. Chemicals to boost agricultural production.
2. Bones that protect lungs and heart.
3. Flow of gases from higher to lower pressure.
4. A drink prepared from processed leaves.
5. Its degree is higher in the case of strong electrolytes.
6. Fundamental particles, which hydrogen atoms lack.
7. An electrically charged species.
9. What a missile does to a target.
12. It uses silver halides which are sensitive to light.
14. An electrode where chlorine is liberated during electrolysis of NaCl.
15. Science that deals with organism in relation to the surroundings.
21. Hooke's law relates it with the strain applied to the body.
22 A converging tube connected to a hose or a pressure chamber.
26. A unit of resistance.
27. Spike of corn-containing seeds.

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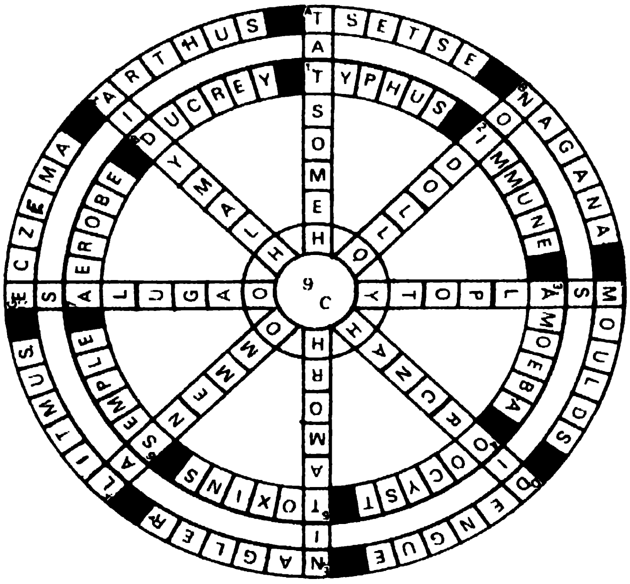
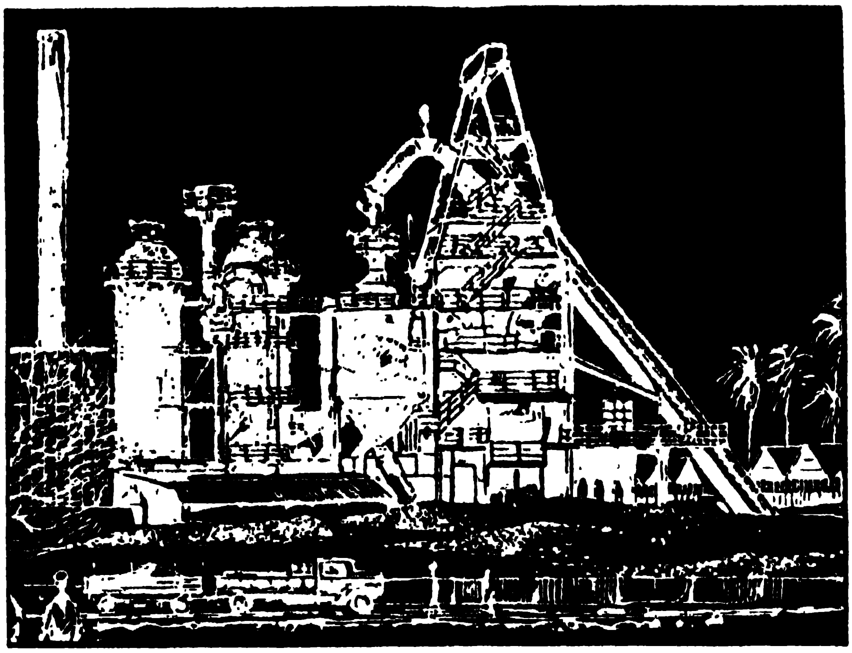


Solution to wheelword Puzzle Published in SR Jan. 1977



SCIENCE IN INDUSTRY

CSIO develops breath alcohol analyser

CENTRAL Scientific Instruments Organisation, Chandigarh has developed a Breath Analyser for estimating the level of alcohol in the blood in order to determine the level of drunkenness in the human subjects. The device has been developed at the special request from the Directorate General of Technical Development, Government of India, New Delhi.

The device is in the form of a small disposable glass tube which would enable police and traffic control authorities to detect cases of drunkenness which might lead to traffic offences. The need for developing this gadget arose because of the high incidence of road accidents which take place due to drunkenness of the drivers of motorised vehicles.

It is known that the consumption of alcohol impairs the judgement and reduces the efficiency of the drivers. The blood alcohol concentration is almost universally accepted as a reliable indicator of intoxication but it is not always possible to conduct blood tests due to certain inconveniences caused to the officials, hospital authorities and the driving public. Fortunately, the relationship between the breath and blood alcohol levels have been found to be reasonably constant for practical purposes. Therefore, in many countries of the world, breath alcohol analysis tubes have been adopted for the determination of the blood alcohol concentration for several years.

In United States, people can be convicted on the basis of the breath analysis alone. In many countries of the world, a blood alcohol level of 80 mg per 100 ml has been accepted as the legal level for convicting purposes.

The device developed at CSIO detects alcohol in the breath and provides immediate information whether or not the driver suspected of having consumed alcohol should be sent for blood examination. The gadget can be used for simple roadside screening tests. If the test is positive, the person could be taken to the police station and asked to provide a specimen of blood or urine. If the alcohol level in the blood exceeds 80 mg per 100 ml of blood the person may be convicted.

The gadget comprises of an indication tube containing a yellow coloured substance and is accompanied with a breathing bag and a mouth-piece. The person to be tested for drunkenness is asked to blow through the mouth-piece till the bag is fully inflated. It takes about 10 to 20 secs. to completely inflate the bag. The blood alcohol concentration is indicated by the green colouration of the yellow colour substance.

In case the blood level exceeds .08% or more, the discoloration reaches the red band marked on the tube. The extent of change of colour of the tube is proportional to the concentration of alcohol in the blood.

Extensive tests on this device have been carried out at the Postgraduate Institute of Medical Education & Research Chandigarh, by actually analysing the blood alcohol level in the human subjects after administering measured quantity of alcohol to them. The experimental results excellently correlated with the level indicated by the tube. A few samples were also given to the Chandigarh Police for carrying out field trials and it is proposed to give them more of these for the same purpose.

The cost of the imported tube is Rs. 15/- whereas the material cost of the gadget developed at CSIO is Rs. 2/-.

It is understood that various state governments in the country are interested to introduce this gadget for mass scale applications. The gadget would thus have tremendous demand and would help save an enormous amount of foreign exchange for the country. There might also be a great export potential for the item as it can be produced very cheaply due to low labour costs in our country.

The design of the gadget has been fully perfected and the know-how of the same is likely to be assigned to the National Research and Development Corporation of India (NRDC) very shortly for commercial exploitation.

The operation of the gadget is very simple. The traffic police constables would experience no difficutlty in carrying out the tests on the roadside.

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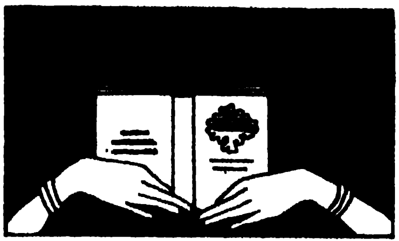

BOOK REVIEWS

.HIGHLIGHTS OF ASTRONOMY By Fred Hoyle, *W.H. Freeman and Co.*, 660 Market St. San Francisco, California 9410411/58, Kings Road, Reading, England, R413AA, pp. 179, Cloth $ 10.00, paper $ 5.00.

FRED Hoyle is no stranger to scientists and science interested citizens. The Kalinga Science Prize Winner has been communicating astronomy to lay readers in the simplest language possible. He is indeed one of those few scientists who are as good in their subjects of specialisation as in the art of communication to laymen.

Fred Hoyle has been a Professor of Astronomy for a number of years. Sometimes he has also shaken the world of astronomy with his fresh and unconventional theories. However, his talent for making science understandable to laymen cannot be questioned.

The book under review is exceptionally beautiful, both for its excellent production and for the presentation of the matter. All aspects of cosmology have been explained simply, interestingly and chronologically. Illustrated pictures have added greatly to the value of this book. There is also a discussion of the perennial question whether there is life in the universe outside the earth. How life originated on this earth has also been discussed lucidly. This book will be a valuable addition to the personal collection of those who want to know how the universe originated and what has been discovered in the past 50 years about it.

INNOVATION SUCCESS AND CREATIVE THINKING by Anand Khare, *Bablu Books Company*, Bangalore-59, Pp. 239, Rs. 45.

EVERY man in this modern age requires creative thinking, whether he wants to invent/discover something or to earn his livelihood. The book under review, as claimed by the author, is meant to serve this all round purpose. But how much it will be a success in this respect I am doubtful. On the whole, however, the book takes one for a costly ride (mind it, the price is Rs. 45) through the various aspects of creative thinking and innovative processes fairly well.

The first part of the book, which is about the "unfreezing the personality" has indeed been well written; but in the second part the author fails to maintain the tempo and one suddenly finds himself to have finished the book, so much abrupt is the ending! The author should have taken pains to comment and brief the reader as to how he should then develop in his life creative and innovative thinking. A slight repetition could have been tolerated to the dissatisfaction one gets after reading it.

Interposed with interesting stories, particularly from Indian folk tales, of Indian kings, poets, scientists, quotations from great and creative people, plus a dash of humour here and there, the "unfreezing of personality", which contains how a peak experience in one's life can change one's way of thinking, how to think creatively by changing the reference frame, how to take idea from an experience and add it to that of another, bringing vague ideas into mind and make them solid, the psychological factors involved, makes a gripping reading. For instance, in the discussion of how to "unfreeze" yourself, arouse confidence in oneself, the author aptly puts in the story of a lion cub, who having been due to circumstances remained in the company of sheep, thinks himself as a sheep and bleats. The author, by including General Patton's words in the World War II to his soldiers that "No bastard ever wins a war by dying for his country, but he wins because some other bastard dies for his country", makes appropriate impression on one's mind as to how man can imbibe in himself spirit by changing reference frame of his thinking.

The second part is serious in content. In it the author discusses the various tools, processes and methods to do an innovation (a term with broad implications). Though he has tried his best to explain everything, every scientific and technical aspect of the problem clearly, giving stories and examples from different walks of life, in the end a reader may wonder where he has been led to? Possibly, this is a result of lack of coordination among the chapters. This part may be of more interest to the management science students and industrialists, who want to acquaint themselves with, for instance, queuing problems, logical dummies, etc.

The book is well produced but priced high to keep it within the reach of managers and industrialists only, in contradiction to the purpose of the book. The style of writing is lucid and impressive. Illustrations are not clear at some places; index is lacking; and there are many "recommendations" on the dust jacket I don't know what for.

DILIP M. SALWI

TEXT BOOK OF PHYSIOLOGY VOL. I. by B.K. Anand and S.K. Manchanda, *Tata McGraw Hill Publishing Company Ltd.*, Asaf Ali Road, New Delhi-110001, Pp. 343, Rs. 42.75

IT has been felt in recent years that reorientation of teaching in science and technology in the country is necessary to expose students to the endogenous problems requiring scientific and technological solutions. And when it comes to the medical education in the country, there needs to be laid special emphasis on clinical and community health services. While the basic or core of any curriculum in medical education remains the same throughout the world, the concept of knowledge through the text books written mostly in Western countries and based on Western experiences is a vexed one, mainly for two reasons: first, the levels of knowledge and skill on the commencement of medical education may be quite variable across countries; second, the learning pattern of students are considerably influenced by the local educational conditions to which students are exposed during studies preparatory to the medical education. Besides, the Western text books presently available for the undergraduate medical student are also very expensive.

The book under review, written by some Indian medical educationists, is however one positive development in this direction; this book is the first volume of a three volume *Text Book of Physiology* for medical students. It is divided into four sections and runs into 334 pages plus a nine page index. The first section includes a brief introduction to physiology and describes physiology of cell and cell membrane, nerve and muscle. The second section deals with various aspects of the physiology of nervous system, and third and fourth sections deal, respectively, with control and regulation and physiology of special sense organs. As mentioned by B.K. Anand and S.K. Manchanda in the preface, the book is written in simple English and would prove easy-to-understand for medical students. Based on the lectures which its contributors have been delivering to medical students over a number of years in the past, the book's style of presentation of the subject is appealing. Another quality of the book is an "organ system approach" which would definitely help students in understanding the basic physiological facts. However, at many places details have been sacrificed and the bibliography is missing—all this done deliberately to make the book brief. Moreover, an inquisitive student could always consult more advanced text books and review articles. The book does justify its merit, but is not the price of Rs. 42.75 for this single volume of a three volume Test Book of Physiology just high in the present context?

DR. ZAKA IMAM

TOWARDS AN UNDERSTANDING OF THE MECHANISM OF HEREDITY by H.L.K. Whitehouse, *ELBS* 1973 (3rd Edition), Pp. XVI + 528, 43s. 0d.

DR. Whitehouse is a Reader in Genetic Recombination at the University of Cambridge. He is a product of the wave of the molecular genetics which originated only after the stimulating discovery of the structure of the DNA molecule. He has devoted himself to the problem of genetic recombination at the molecular level. As a result, he proposed the molecular mechanism of crossing over and this hypothesis is known as "Hybrid DNA Model". The book under review aims at giving the reader an overall view of the subject. It includes the recent major advances in the field of general and molecular genetics. A good attempt has been made to give a balanced picture with a great emphasis on principles and concepts alongwith the most recent research in the field of genetics.

There are in all eighteen chapters and each chapter deals with a particular theory. In each chapter the major discoveries are given in the order of their occurrence. The important contributions are illustrated with appropriate experimental observations. Each chapter ends with a very well written 'Conclusions' for clear understanding.

Dr. Pontecorvo of the University College, London, has rightly pointed out, in his Foreward to the Whitehouse's book, that "It traces the basic ideas of Genetics through their development and describes concisely, yet without omitting any essential detail, the critical experiments which led to the establishment of each of those ideas. This historical approach........is not at the expense of keeping abreast with the advancing frontiers". The sequence of chapters is also more or less linked to the sequence of development of understanding of genetic mechanisms.

A well written 10 page glossary of genetical terms is included for the benefit of the students. However, no pains have been taken to explain the process of protein synthesis diagrammatically in Chapter 14. Also, it does not deal adequetely the important fields of population genetics, human genetics and evolution.

In short Dr. Whitehouse must be complimented for producing a work that really reflects the growth of a science. However, this book cannot be recommended for the undergraduate courses of Indian Universities. But it can be a very good text book for the Post-graduate students.

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A FIRST COURSE IN APPLIED ELECTRONICS, by W. Gosling, *Macmillan Press Ltd.*, London, 1975, p. 162, £ 2.95. Representive in India: 2/10 Ansari Road, New Delhi-2

LIKE discrete component circuits, integrated or microelectronic circuits are systems of interconnected transistors, diodes, resistors and capacitors. The difference in discrete and integrated circuits is that the monolithic integrated circuit is made exclusively within a single crystal of semiconductor silicon—all the components being formed and interconnected in a single series of processing operation. Microelectronic circuits are quite small in area. Seven or eight transitors used in complicated amplifier can be accommodated on only a millimeter square of semiconductor slice surface; the slice being a fraction of millimetre thick. Usually, an integrated circuit contains tens or hundreds of components formed within a single silicon crystal. As regard the cost, technical specification, re liability and size, integrated circuits are indeed superior.

The amplifier is the most important of all electronic circuits. The book under review is based upon microelectronic amplifiers. The one, who hopes to design integrated circuits, will have to refer the subject back to its physical origins. For the majority of the professional engineers interested in the application of integrated circuits in complicated electronic systems, however, the physical processes occurring within microcircuits have less importance. The author, who is a Professor of Electrical Engineering at the University of Bath has thus rightly designed the book regarding the properties of the microcircuit as the basic point and developing a complete theory of applied electronics at an elementary level.

The book begins with an introduction to electronics where the author has discussed the need of the integrated cirtuits, their fabrication technology and amplifiers in general. The fundamental principles of amplification have been described in Chapter 2. In this chapter five kinds of the most important amplifiers have been described and of these only two, the variable dissipation amplifiers and the switching amplifiers, are likely to find use in integrated circuits. In Chapter 3, the amplifiers have been discussed in detail. Noise can arise in amplifiers from a variety of different processs, swhich are included in Chapter 4.

As the name suggests, the feedback is a technique of taking out some of the output power from the amplifier and feeding it to the input circuit again. By the use of feedback the characteristics of the amplifiers can be modified. A considerable portion of the book has been devoted to the theory of feedback, its use in practice and feedback problems. Both wanted and unwanted effects of feedback on amplifiers have been described.

The architecture of the book is good. An important feature of the book is that each chapter ends with a number of problems, the worked-out answers of which have been given in the end. A list of appropriate references has also been included wherever necessary, which enables the reader to find sources of further study. The book provides a pleasant reading with short and useful proofs. It has been lucidly written with remarkable coherency. There are only a few mistakes (for example 'E' represents both efficiency and voltage in a single equation on p. 10, i.e., $E = \frac{E-V}{E} \cdot 100$)

The book is useful for self-study, students of technological courses, and professional engineers engaged in integrated circuits.

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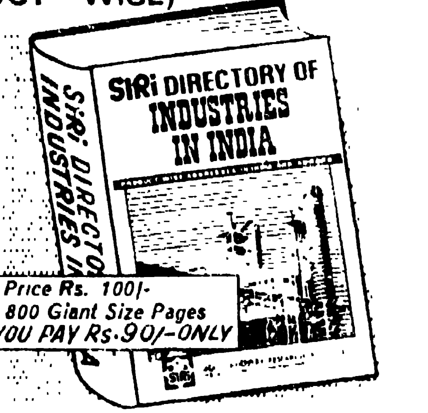
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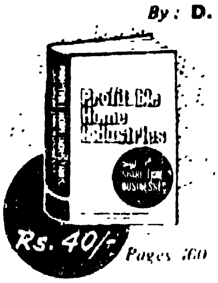

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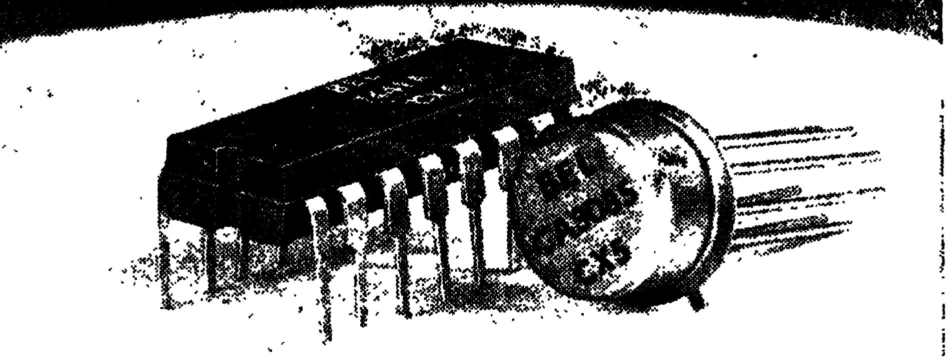

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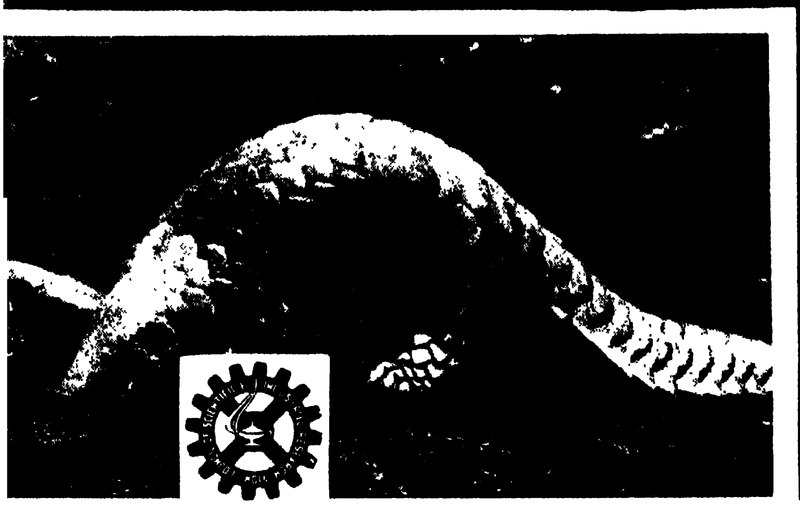

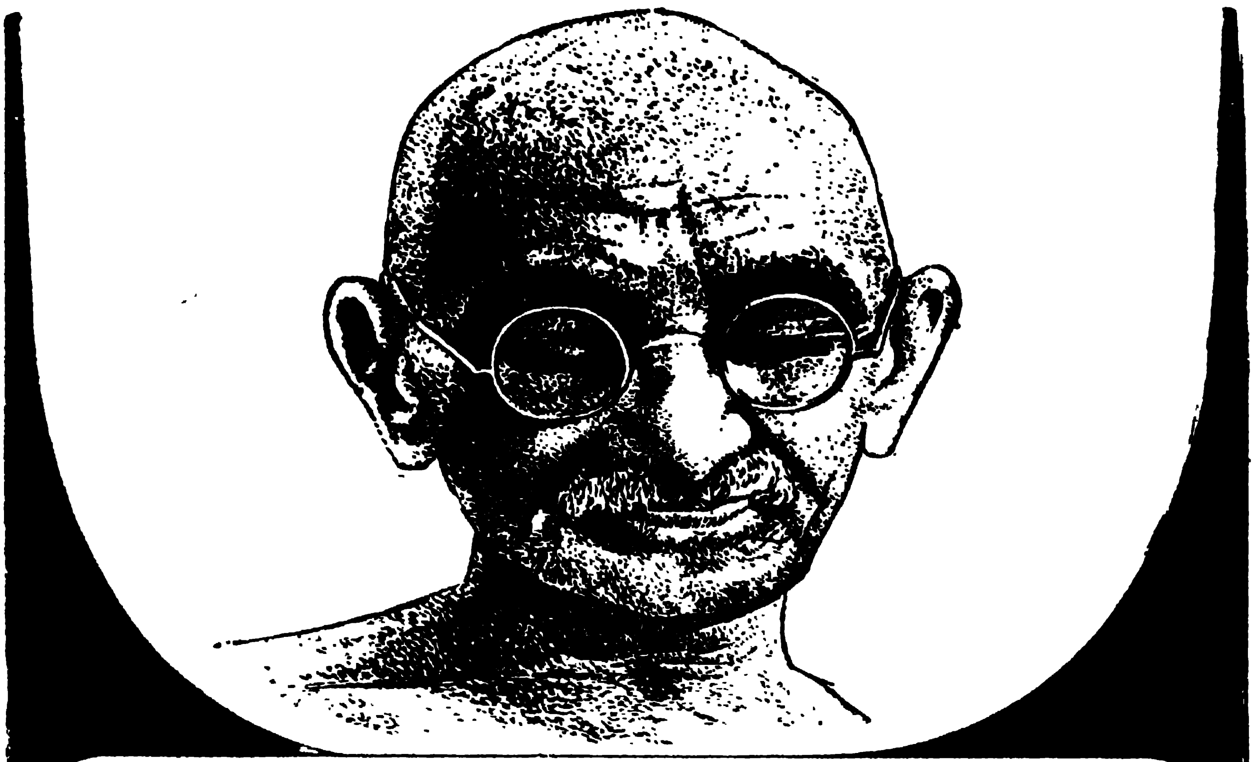

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LETT

Retinal detachment

Sir, **Retinal detachment can cause blindness** (*S.R.*, Aug. and Sept. 1976) was very interesting. Please let me know about the aetiology of the detachment of retina. Why does retina get detached from the choroid? What is the pathogenesis of the case and why is retina detached from the upper fundus more frequently than lower fundus?

RAMENDRANATH DALAL
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The immediate cause of retinal detachment is the development of retinal breaks or holes, through which the degenerated fluid vitreous flows under the retina lifting it and causing a retinal detachment (Fig. 5). How and why are retinal breaks caused has been a subject of great interest to ophthalmologists for decades. In my article **Retinal detachment can cause blindness** (*S.R.*, August 1976), I have described the most accepted concept under the headings; "Causes of retinal tears" and "Vitreous in the mechanism of development of retinal tears". In short, the degenerated shrunken vitreous pulls on the retina (where it finds abnormal attachments) during sudden change in motion to cause retinal breaks. The vitreous degeneration and its abnormal attachment to the retina is determined by certain genetic defects and is closely related to short-sightedness or myopia.

Since gravity aids formation of retinal tears by downward shift of vitreous and also facilitates accumulation of fluid behind the retina leading to retinal detachment, not only the tears are more commonly formed in the upper quadrant, but once formed they quickly and easily lead to retinal detachment.

DR. B. PATNAIK
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Explosions of the galactic nucleus

Sir, Drs. S.B. Karanjai and S.K. Barman (*S.R.*, Jan. 1977) have mentioned that the formation of the 3 kiloparsec arm is due to an explosion at the centre of the galaxy, perhaps 10^7 years ago. According to K. Ishida (*Supp. Prog. Theo. Phy.*, **31**, 116-130, 1964) the 3 kpc arm, which is believed by J. H. Oort and others (*M.N.R.A.S.*, 118, 379-389, 1958) to be a fullfledged spiral arm and which is moving towards us with an outward radial velocity of 50 km per sec, is the result of an explosion at the centre of the galaxy,$\sim 2 \times 10^7$ years ago.

The flowing of gas at the solar neighbourhood, from the halo, has been suggested by K. Ishida in terms of an explosion,$\sim 5 \times 10^7$ years ago and the presence of large scale galactic halo to an explosion of the galactic nucleus 10^8–10^9 years ago.

Besides our galaxy, there are unambiguous proofs of explosive activities in extra-galactic objects. This phenomenon is considered to be fairly common. According to K. Ishida "all normal galaxies must have experienced enormous explosions 1-10 times in 10^{10} years". Seyfert and radio galaxies are believed to be caused by the explosion of the nucleus. G.R. Lynds and A. R. Sandage (*Ap. J.*, 137, 1008-1021, 1963) have reported evidences of an explosion in the central region of *Messier 82*. This is regarded as the most direct evidence of an explosion of the nucleus of the galaxy. E. M. Burbidge *et al.* (*Ap. J.*, 140(3), 942, 1008, Oct. 1964) have arrived at the same conclusion, of the explosive activity of *M 82*, from a study of the velocity field in that galaxy and K. Aizy *et al* (*Supp. Prog. Theo. Phy.* 31,, 35-61, 1964, have even proposed the Pile Theory to explain the mechanism of the explosion.

S. K. GURTU
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The riddle of gravitation

Sir, I thank you for the article **The riddle of gavitation** (*S.R.*, July 1976). However, there is one important point which the authors seem to have overlooked. The Theory of Relativity does not say that no physical object can move with velocity greater than that of light, it just says that no physical object can travel *at the speed of light*. This small but vital difference has given rise to Prof. Gerald Feinberd's papers *On the possibility of faster than light particles* (Ref : *Promise of Space* by A. C. Clarke). Herein lies a vague distant hope of smashing the light barrier without violating the relativity principle.

S. C. MAHAGAOKER
B. H. U., I T
Varanasi

The statement of the first postulate of the Special Theory of Relativity mentioned in our article is indeed faulty. It was an oversight and we highly regret this error. At the same time the statement given by Shri Mahagaoker that "no physical object can travel at the speed of light" is also incorrect. The correct statement is that the velocity of light (in vacuum) is a universal constant, independent of the motion of the source and the observer. The observation that no physical object can travel at a speed greater than that of light is a consequence of the postulates, within the framework of the special theory of relativity. Photons and neutrons do travel at the speed of light, and they are physical objects. In fact, according to quantum electrodynamics every massless particle must travel exactly at the speed of light. We would not like to comment, at this stage about particles travelling faster than light.

A. W. JOSHI
S. S. CHOUDHARY
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Variable stars

Sir, Variable stars have been classified into four types by Dilip M. Salwi, **The stars that pulsate**, (*S.R.*, Aug. 1976). In one type , there are hotter or colder regions, according to the author, whose rotations cause light variation. Now almost all the stars are rotating with hotter (photosphere) or colder (starspots) regions. So, we should expect the stars to fluctuate in brightness. This is not so. The sun, for example, has an almost constant radiation output, though there are sunspots on the surface participating in the general rotation with lesser temperature than the surrounding photosphere.

Surprisingly, Mira type variables and flare stars have not found a place in the author's classification.

S. K. GURTU
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Light

Sir, In **The riddle of gravitation** (*S.R.*, July 1976) by A. W. Joshi and S. S. Chaudhury the quotation by Alexander Pope reads :

> *Nature and Nature's laws lay*
> *hid in night,*
> *God said 'Let Newton be'*
> *And all was right.*

Here a slight error has crept in. It should have read "Nature .... And all was **light.**" One letter either wrongly printed or misquoted makes the quotation dubious. Newton's work on light is unforgetable contribution to science.

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Gravitation

Sir, In *S.R.*, July 1976, A.W. Joshi and S.S. Chowdhury have given a very interesting and informative review of the various theories of gravitation including the latest one put forward by K. P. Sinha and Sivaram. But it is unfortunate that there is no mention of Hoyle-Narlikar theory, which at one time attracted the attention of all. They based their theory on Mach's principle of action at a distance. According to them, mass of a body is not its inherent property but is dependent on the entire mass of the universe. This theory also explains why there is always attraction and no repulsion in gravitation.

A. K. DAS GUPTA
Calcutta-700033

Heavy metals

Sir, **The heavy metals** by Sunil P. Pande (*S. R.*, May 1976) was quite interesting. Selenium does not belong to the class of metals. Arsenic, antimony and selenium are better known as metalloids. Selenium displaces sulphur from sulphur-containing proteins. Excess selenium in the soil causes formation of protein-selenium compounds in crops. Drinking water contaminated with selenium is one of the causes of formation of protein-selenium compound in the body of the animals. Alkali diseases of the cattle result from the protein-selenium compounds formed in the body.

Presence of a little selenium in rats is essential. Lack of selenium destroys the action of glutathion peroxidase in blood of the rats. This results into hepatic necrosis in rats. Growth of sheep is retarded by lack of selenium. Administering selenium compound to cattle and pigs rescues them from hepatic dystrophy.

The enzyme, glutathion peroxidase, contains selenium. It prevents unwanted oxidation by peroxide in cells of rats.

LALITA PATTREA
Lecturer in chemistry
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Nodulation in plants

Sir, I read the article **Nodulation in plants** by Sukumar Chatterjee (*S. R.*, January 1977) with interest. The author is not correct when he writes "Strangely, the bacteria cannot fix nitrogen outside the nodules when they are artificially cultured in the laboratory".

In fact, recently Pagan *et al.* (*Nature*, July 31, 256 : 406) have shown that a strain of *Rhizobium* 32H 1 could fix nitrogen when they were artificially cultured in a defined medium, in absence of plant cells. A key factor in the culture medium proved to be a carbon source, a pentose sugar such as xylose a arabinose, as well as a dicarboxylic acid such as succinate.

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Articles

Sir, We thank you for publishing useful articles in *Science Reporter* every month. The articles increase our knowledge about the latest developments in science and technology.

We request you to publish more articles on health problems (common diseases, causes, possible remedies, etc., with illustrations) and also topics on various small scale industries for the unemployed youth (finance, raw material, technology, marketing, etc.).

V. NIRANJAN SASTRY AND COLLEAGUES
Department of Chemistry
Atomic Energy Central School
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Suggestions

Sir, I have been a subscriber to *S. R.* for the past one year. It is of great help to students, appearing in competitive examinations, especially to the students appearing for the National Science Talent Search Examination of NCERT.

I would like you to publish articles on topics such as detergents, biopolymers, biological clocks, etc. These articles will be of great use to science students.

R. CHANDRA SHEKAR
B-77 Airport Colony
Madras-600027

II

Sir, I am subscribing to *S. R.* regularly since January 1970. I made all the back numbers into bound volumes. The magazine helps immensely the teaching and student communities in understanding the recent developments in various branches of science. I utilise articles on biology in my classroom for the benefit of students. I wish you greater success in the years to come.

S. GHULAM MAHMOOD
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III

Sir, I have read *S.R.* of January 1977. In every article I found certain words above the standard of a common reader. I would therefore suggest that a vocabulary of the difficult words and abbreviations (if any) be given at the end of each article.

Besides, I would like you to publish articles on human psychology and psychological diseases every month if possible.

S. A. AHMED
12-Poloview
Srinagar, Kashmir-190001

Statement about ownership and other particulars about periodical

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(*See rule 6*)

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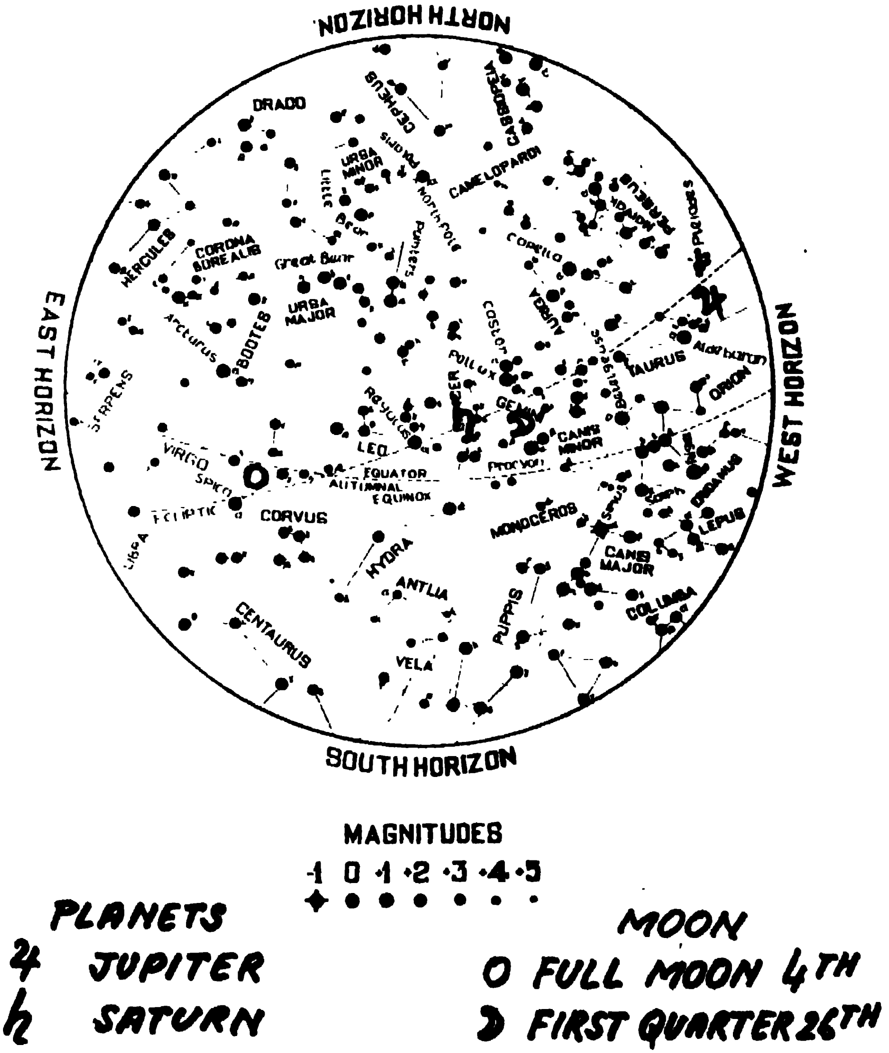
I, S.P. Ambasta, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-
(S.P. Ambasta)
Signature of Publisher

1-3-1977

Planets and their positions

APRIL 1977



FULL moon occurs on 4th at 9-39 a.m. and new moon on 18th at 4-05 p.m. I.S.T. The moon passes about four and a half degrees north of Mars on 15th and same amount south of Venus on 17th, five degrees south of Mercury on 19th, about three degrees south of Jupiter on 21st and six degrees south of Saturn on 27th. The lunar crescent becomes first visible after the new moon day in the evening of 19th.

The moon is at perigee or nearest to the earth on 6th and at apogee or farthest from it on 21st.

There will be a partial eclipse of the moon on 4th, but it will not be visible in India.

There will also be an annular eclipse of the sun on 18th. The eclipse will be visible in India except in northern and north eastern parts before sunset as a partial solar eclipse.

The planets

Mercury (*Budha*), or the evening star sets, about an hour after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible being in inferior conjunction on 30th. It is at the greatest eastern elongation of about 19 degrees from the sun on 10th and becomes retrograde on 20th. It is in Aries (*Mesha*). Its visual magnitude varies from -0.9 to +2.1.

Venus (*Sukra*) is too near the sun to be visible during the first quarter of the month being in inferior conjunction on 6th. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It becomes direct on 27th. It is in pisces (*Mina*). Its visual magnitude varies from —3.1 to —4.1.

Mars (*Mangala*), visible in the morning sky, rises about one and a half hours before sunrise during the month. It moves from Aquarius (*Kumbha*) to Pisces (*Mina*). Its visual magnitude is about +1.4.

Jupiter (*Brihaspati*), an evening star, sets about three hours after sunset during the first half of the month and about two hours after it during the second half. It is in Taurus (*Vrisha*). Its visual magnitude is about —1.6.

Saturn (*Sani*), visible in the evening sky, sets about two hours after local midnight during the first half of the month and about an hour after it during the second half. It becomes direct on 11th. It is in Cancer (*Karkata*). Its visual magnitude is about +0.4.

Source: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N', New Alipore, Calcutta-53.

They are wild but need our protection

Wild life conservation is vaguely and poorly understood in India

G.M. NATARAJAN

THE population of many animal species has been changing since prehistoric times. Many animals have died out and others have come close to extinction as a result of climatic and geographic changes. This process is still continuing, in fact, at a faster rate, because of the active interference of man. I will not enlarge here on man's savage and senseless treatment of the world's animal population. They are well-known and speak for themselves.

It is estimated that over the past two thousand years 106 species of animals and 139 species of birds have become extinct. Man's impact on nature was relatively slight in the first eighteen centuries of this period. But later the rate of his destructive advance increased. Last century seventy species of animals became extinct, and in the last fifty years forty species have vanished from the earth. At the present time annihilation has become even more intense.

The *Red Data Book*, introduced by scientists to record animal and bird species threatened with extinction and for whom remedial action is necessary, lists 600 species. The population of a number of species is well below one hundred, and in some cases it is less than ten. The *Red Data Book* can be seen as a document of human conscience, of the responsibility of all towards the preservation of nature. Unfortunately, there are still many people who do not consider the problem of wildlife conservation of any consequence. Why, they ask, should any man bother to preserve and protect the black buck or some small bird listed in the *Red Data Book* ? The answer is that there are many and compelling reasons why he should. Any species of wildlife, animal or bird, is a unique creation of nature with its own specialised mode of life, organic structure, and individual behaviour. One can reconstruct a temple, a palace or a machine by a plan or description,

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but it is impossible to reconstruct an extinct life form.

And, has man realised all the economics and other possibilities of living nature? For example, the bodies of animals have long served man as models for his development of various instruments and machines. The principles employed in converting external stimuli into biological receptors have formed the basis of a new science—bionics, and play an important role in designing computers and instruments. In other words, it is to animals and insects that man has looked for many of his discoveries and inventions. And all this is in addition to the fact that by loosening the soil, spreading seeds and controlling insects and other pests that sap the strength of trees and plants, animals play a direct and essential part in the life of the forest and earth. Then there is the vital role played by animals in man's economic life in the sphere of food production, including livestock farming, and as a source of raw materials. And, finally, there are important moral and aesthetic aspects to the problems in addition to the lessons learned from the past. If these lessons continue to be ignored man may end up with a world of only insects, sparrows and mice.

A flight of cranes in spring, the song of cuckoo, the mighty tiger in the forest, do something for our spirit, bring us joy.

Today, six hundred animal species are on the endangered list, which means that these animals will disappear unless urgent measures are taken over the next thirty years. Meanwhile, other species are being added to the list. Can these threatened species be saved ? Experience in India in the field of wildlife protection gives an encouraging answer to this question.

India has about 500 species of mammals, 2060 species of birds, 748 species of reptiles, and 29,700 or more species of insects. A mere enumeration of animals living in one state of India would fill a number of pages.

The mad destruction of animals occured during British rule in India also. As a result many animal species, especially lions, tigers and cheetahs were almost wiped out. In Assam, Colonel Pollock—a military engineer, shot a rhino or a buffalo for breakfast almost everyday, to judge from the descriptions he left. A former Raja of a state in Madhya Pradesh probably holds the world record for tigers killed; his bag is over 1,000 tigers. He apologetically described his depredation as "killed 1,170 tigers only". Such animals as the Nilgai, Black buck, four-horned antelope, Indian Gazelle, one-horned rhinoceros, and many species of birds were near extinction. This harsh legacy from British times is still with us today.

Even in the post-independence period, our development activities placed perfect tools and techniques in the hands of vast unimaginative section of the people. The exuberance of independence is said to have resulted in a large-scale massacre of wild animals, in many of the shooting preserves of erstwhile princely states, as in Janjira, South of Bombay, where villagers went out and killed 200 cheetahs and paraded their kill on the streets in celebration of Independence Day! What was worse, the forest departments of the states in which the princely states merged, disbanded the game departments of the latter and relegated game protection to a secondary place. For quite sometime, the wildlife lost even the dubious protection it had enjoyed in the princely states.

Paradoxically in no other country is life valued in theory so much as in India and many people would even hesitate to destroy the meanest or the most harmful of animals. Ashoka's third century B.C. pillar edict gives the names of birds, beasts, fishes, and probably even insects that are to be afforded protection in his empire. Kalidasa's hunting deer, Kamban's Hanuman and Kautilya's "Abhayaranya" are some of the other important references to our wild life.

India was probably the first country to enact a Wild Life Protection Act. The Wild Birds and Animals Protection Act was passed in 1887 and was repealed in 1912. The Forest Act XVI of 1927 dealt with game protection in the states. Various states, notably the Punjab and Bengal, also enacted their own laws. In 1952, the Government of India, by a resolution constituted the Indian Board for Wild Life. Based on the recommendations of the Board, the status of several animals and birds in the country was classified into: (a) those that are threatened, (b) those that are of special category needing protection, and (c) big game and small game and Vermins.

By the new Wildlife Protection Act of 1972, the threatened species are absolutely protected and the rest are afforded graded protection as they appear down in the classification. Under this Act possession, trapping, shooting of wildlife alive or dead, serving their meat in eating houses, their transport and export are all controlled and watched by special staff namely the Chief Wildlife Warden and the authorised officers.

Chapter III of this Act prohibits hunting of females and young ones except that of Vermin.

However, to prohibit hunting of animals is only one step in the work of protecting them. It is also necessary to know about them. For instance, the lion-tailed macaque is an interesting object for study. It is usually moving in troops of 12 to 20 animals. Sometimes lone males or courting couples may be seen. The sex ratio of male and female is 1 : 3 and the reproduction and

Fig. 1. Great Indian rhinoceros in Mysore zoo

population increase is yet to be studied. The longevity and mortality is not known. And the remarkable antagonistic behaviour of the troops remains an enigma to scientists to this day. On the initiative of the Tamil Nadu Government the entire Kalakkadu Reserve Forest in Tirunelveli district has become a sanctuary and a research programme has been launched to study the behaviour of these animals extensively.

Tiger is a good example of what can be done with scientifically-based and rational measures for the protection of wildlife. By the end of 19th century, the tiger had been all but destroyed in India, especially in central and eastern regions. In 1973 the Government of India launched the "Project Tiger". A total prohibition on poaching and hunting of tiger was imposed. As a result of the measures taken by the government the tiger population has grown considerably and the area of its habitat has expanded.

When an animal or bird species appears on the critical list the government's first and most effective measure is to impose a total ban on hunting. The hunting of the now rare birds such as the flamingo, pelican, bustard, great white crane, openbilled stork, grey heron, pink headed duck and mountain quail is prohibited. Limited hunting may be allowed at some future date, but never near the mating sites of the birds or where they gather during the mating season. Other measures include the establishment of reserves, the provision of feeding stations along migration routes and in the wintering places of birds, the protection of seashore colonies of birds, and the introduction of water-fowl to new reservoirs.

Good progress has been made in protecting Gir lions. The protection of Gir lions is of great national significance. Despite succession of drought years, Gujarat Government has taken all possible steps to increase the number of animals. A 48 lakh rupees scheme launched earlier by the Gujarat Government to protect the Gir lions will be completed soon.

With regard to enforcement of regulations every Indian state has its own wildlife wing in the Forest Department and additional field staff for effective enforcement of the Wild life (Protection) Act.

In India the first reserve to be established was the Manas in Assam and the second, the Kaziranga. The Kaziranga sanctuary shelters the one horned rhinoceros, one of the world's rarest and peculiar present day monsters. At present the Indian sub-continent has more than fifty sanctuaries which occupy a total area of about 12950 km.

Sanctuaries in India include such natural features as unique landscapes, broad-leaved forests, mountain forests, virgin bushlands in deltas of big rivers, all of which give a fairly clear idea of what the country looked like in the past, together with its rare animals and plants, etc., The sanctuaries also serve cultural and educational purposes, and are visited by scientists school and college students and tourists.

In addition to the sanctuaries, India has national parks, protected areas and reserves. The national parks are for public recreation and tourism. The number of national parks in India is steadily growing. Every year there is establishment of new reserves also.

Despite all these measures taken by the Government to protect the fauna and flora of our country, it is really distressing to know that India has lost about 200 animal and bird species since the beginning of Christian era; and the rate of loss of wild animals alone was, according to one estimate one for every 55 years upto the last century and since then, at a staggering rate of one animal for every one and half years. 250 other species are now about to be lost. In fact, it can be said that, with very few exceptions, most of our wild animals today are balancing precariously over the precipice of extinction.

In India, the setting up of nature protection reserves has received special attention. In the last century the necessity was realised of providing birds and animals with places

"Is it available to our home life too, Dear?"

About the extinct!

THERE was a time in the past when giant dinosaurs had ruled the earth. Ghastly looking as they were, the only evidence of their past existance is fossils which were preserved in nature. While everybody would be happy that the dinosaurs vanished, the biologists may, however, repent that they did not get one to study its behaviour and physiology. Biologists have been speculating about the various physiological aspects of the extinct dinosaurs by relating their height and hydrostatic pressures in the vascular system. Why is there an interest in those extinct animals? Naturally, it is important from the biological point of view. But one wonders if we are really interested in the wildlife because a number of species are threatened with extinction. Would we be able to save enough living specimens of today's endangered species so that our future generations do not hold us responsible for depriving them of this natural heritage?

Z. I.

of refuge—sanctuaries—where they would be fully protected by law. That is how nature reserves came into being. However, their purpose is not only confined to protection of animals but much wider.

In many parts of our planet nature has been modified and distorted by the impact of man. But to study nature it is necessary to have areas of truly virgin pristine landscape where animals, plants, the soil, etc., are in their natural state. This is the primary aim behind the setting up of nature reserves and parks, preserving, as far as possible, a true criterion of nature.

Nowhere in the world had destruction of the natural wilderness, the habitat of wildlife proceeded with such speed and totality as in the Indian sub-continent. It has been the most decisive factor in the catastrophic diminution of India's wildlife within and outside the sanctuaries in the last 25 years.

The decline of the wildlife of India also stems from the demands of our exploding population not only on forest products but on the forest land itself. With the extension of cultivation into the forest it has now become a question of survival for many species like the Blackbuck, the Chinkara and the Indian wolf, to mention only a few. They exist only in precarious survival pockets and their assured existence depends on the success of the conservation movement. The swampdeer and the Nilgai have made their last stand on the periphery of the forest. Their further retreat is limited by a hostile habitat and their survival is in balance. When forest disturbance is universal and the forest canopies resound with material quests, where is the animal to breed, and where to rear its young ?

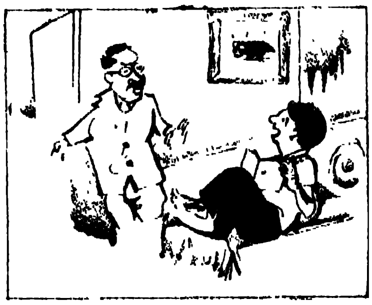
Human predation also continues unabated. The illegal fur trade is still rampant inspite of export bans. Wildlife conservation is but vaguely and poorly understood in India, and the public feeling for the animals is entirely indifferent. Tribal hunters in certain favoured areas increased in numbers. Forest-based tribes also have in recent years successfully destroyed every vestige of wildlife.

The forest department is only a commercial organisation and all its efforts are directed towards increasing revenue. Heavy cattle grazing and timber exploitation take place in parks and sanctuaries with the adverse effect on wildlife reproduction. So far as India is concerned, the proliferation of the cattle population is the greatest menace threatening wildlife. Domestic cattle, many of which are diseased, transmit their parasites to the wild animals particularly ungulates, in addition to competing with them for food in the over-grazed forests.

Fig. 2 Feeding Station in a Reserve Forest

Many people believe that Africa's wildlife is the richest in the world. But zoogeographical evidences point out that Africa's wildlife had its origin only in India. Unique forms of our country are antelopes, namely, Nilgai, black buck, four horned antelope and the Indian Gazelle. Black buck is found in no other country. Four horned antelope is the only antelope with four horns in the world today. But no other country has even these four forms of antelopes. Africa is rich in numbers, but India in variety and interest. Incredible as it may sound, there is no deer in Africa, India has several forms. Further, India shelters Gaur or the Indian bison, the biggest wild oxen living in the world today, which is not found in Africa. India is the only place in the world, next

(Continued of page 168)



"But it is no more punishable to be wild, Dad"

DILEMMA IS WAVE OR PARTICLE?

A. W. JOSHI

Does every object in this universe, small or large, show the wave-particle duality? In principle, yes. But the wave properties of matter dominate only in the microscopic domain and become negligible in everyday objects

THE dilemma about the nature of light is an old one. The famous British scientist Sir Isaac Newton (1642-1727) was one of the pioneers who advanced a definite scientific theory of light. He suggested that light consists of particles or corpuscules which travel in straight lines and carry energy. By this simple theory, Newton easily explained the rectilinear propogation of light and its spectrum. According to him, corpuscules of light of different colours have different energies, though all of them travel with the same speed, the speed of light c ($\simeq 2.997925 \times 10^8$ m/sec in vacuum). He also explained the refraction of light by using the observation that the velocity of light in material medium is lower than that in vacuum.

A little before Newton, Christian Huygens (1629-1695), a Dutch mathematician, astronomer and physicist, had advanced the wave theory of light. According to it, light is a wave travelling in an all-pervading medium named 'ether' just as sound travels in gases, liquids or solids. He also explained the phenomena of rectilinear propagation of light, reflection, refraction, double refraction, etc. He noticed the polarization of light but did not give any attention to it.

For about 100 years, not much advance was made in understanding light. The corpuscular theory and the wave theory continued to be the main rivals. Adherents of each theory tried to explain all phenomena of light in terms of their theory. For example, polarization of light was explained by the corpuscular theory on the ground that a ray of light may be more like a flat rod rather than a circular one. On the other hand, in the wave theory, it was explained by suggesting that light consists of transverse waves in ether.

The dawn of the nineteenth century saw the wave theory gaining a distinct lead over the corpuscular theory. In 1801, Thomas Young, a British physicist and physician, discovered the principle of interference and found that this spectacular phenomenon could be explained by the wave theory alone. In the latter part of the nineteenth century, another British physicist James Clerk Maxwell (1831-79) gave the first sound theoretical foundation for the electromagnetic phenomena and showed that light is a small part of the wide electromagnetic spectrum. The discovery of artificial production of electromagnetic waves and their reception, by the German physicist Heinrich Rudolf Hertz around 1885, was another milestone towards understanding the nature of electromagnetic radiation. So, at the end of the nineteenth century, there was no doubt among physicists that light, and electromagnetic radia-

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tion as a whole, consist of waves.

At the turn of the century, the German physicist Max Planck (1858-1947) once again revived the corpuscular idea and suggested that light consists of quanta of energy. In other words, light cannot possess a continuous spectrum of energy but a ray of light of frequency ν (nu) must have an energy in multiples of $h\nu$, where h is a constant, now known as the Planck's constant. Planck was studying the intensity versus wavelength variation of the radiation emitted by a black body and there was no good theory to explain this phenomenon, the black-body radiation. Planck found that with the quantum hypothesis his results agreed extremely well with observations. There was no other experimental observation to support the quantum hypothesis except that the formulas derived on this basis agreed with the observed spectrum of black-body radiation. Planck himself, however, was not happy with this hypothesis. He described it as an act of desparation, done because some theoretical justification had to be found.

Soon in 1905, Albert Einstein (1879-1955), another German physicist, used Planck's idea of quanta to explain the photoelectric effect successfully, providing a strong support to the corpuscular view of radiation. Later in 1923, Arthus Holly Compton, an American physicist, performed experiments on scattering of light from electrons and showed that the results could be explained only by assuming that light consists of quantized photons.

Although the corpuscular theory gained considerable support in the beginning of the present century, the fact remained that the phenomena of interference and diffraction could be explained only by assuming light in the form of waves. Faced with such facts, physicists began to believe that electromagnetic radiation is a complex phenomenon and shows the dual character; in some experiments it behaves like waves and in others like particles.

Wave-particle duality

Maurice de Broglie (1875-1960), a French experimental physicist, supported Compton's views on the particle nature of radiation. His brother, Louis de Broglie was studying history. Coming frequently in contact with his elder brother and his discussions with other physicists, Louis became interested in the dual nature of radiation. He thought that if radiation (which was supposed to be wave-like) shows particle properties, matter (which was supposed to be particle-like) should also possess wave properties. Believing strongly in the symmetry of nature, he left history for physics and in 1924 submitted his ideas in a thesis to the faculty of science of the University of Paris for the degree of Ph.D. In the thesis, he considered the relation between wavelength and linear momentum of a photon and argued that the same relation should also give the wavelength of a material particle. This relation, now known as the de Broglie relation, is $\lambda = h/mv$, where λ is the wavelength, h the Planck's constant, m the mass and v the velocity. Since wavelength is a wave characteristic and mass is a particle characteristic, the de Broglie equation relates the wave properties of an object to its particle properties.

The thoroughness and clarity of de Broglie's thesis impressed the academic world. His argument was philosophically correct and logically sound. However, owing to the lack of experimental evidence, it was thought that his idea of "matter waves" is merely an abstract idea and has no physical reality.

Then in 1927 came a dramatic and accidental confirmation of de Broglie's idea of matter waves. Sir George Paget Thomson, a British physicist, and C. J. Davisson and L. H. Germer of the Bell Telephone Laboratories, U.S.A., who were bombarding electron beams on crystals and observing electrons scatter in different directions, found that the results were identical to those of X-ray diffraction from crystals and could be explained only by assuming that the electrons were behaving like waves. From the observed diffraction pattern, they calculated the wavelength of the wave, and knowing the velocity of the incident electrons, found that it agrees exactly with the value predicted by the de Broglie relation. Soon it was found that atoms and molecules (and much later, neutrons) of suitable energy bombarded on crystals showed diffraction pattern, and in each case the wavelength obtained from experiments agreed with that given by the de Broglie relation. After this overwhelming confirmation of his ideas, Louis de Broglie became the first physicist to receive Nobel Prize in 1929 for the work he did for the doctoral degree.

Let us see a simple idealized experiment to understand the phenomenon of diffraction. Consider a diaphragm in which there are two parallel slits A and B as shown in Fig. 1. On one side of it, there is a source S of light or electrons, or atoms or neutrons or any suitable object. On the other side, there is a detector D or a photographic plate PQ. For electrons, a Geiger counter could be used as a detector. Consider the situation when electrons are taken as incident particles.

Suppose first the slit B is closed, keeping only slit A open. Further, suppose that the flux of the incident electrons is such that the Geiger counter counts two electrons per second at a certain position. Now close the slit A and open slit B. Once again suppose the Geiger counter counts two electrons per second. Now open both the slits. If electrons

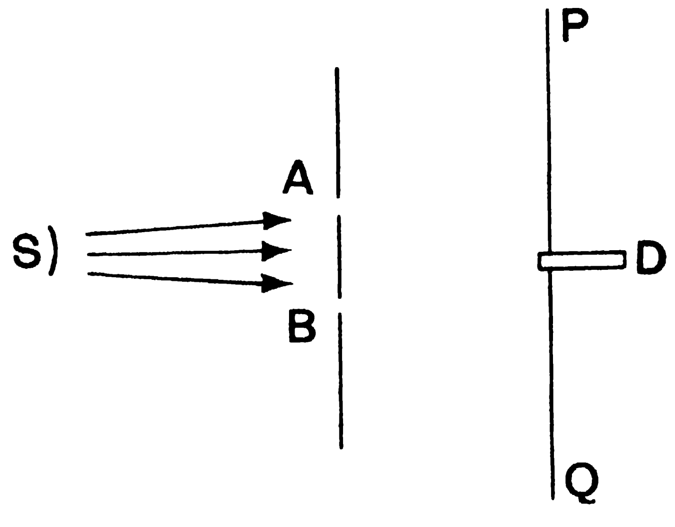

Fig. 1. Diffraction through a double slit

are particles, we expect to count four electrons per second. In reality, it is found that the count rate is anywhere between zero and eight, depending on the position of the detector D along the line PQ. If a photographic plate is used in the position PQ, a pattern of alternating bright and dark interference fringes will be seen. Dark fringes correspond to the regions which receive no electrons while bright fringes occur where a large number of electrons are incident. The observed intensity pattern along the line PQ would be as shown in Fig. 2. Essentially the same result would be obtained if a source of light or neutrons or atoms in place of electrons is used.

If electrons are particles, we could pin-point exactly through which of the slits each electron passes. Electrons passing through one slit should not be affected by closing or opening of the other slit. When both slits are open, the number of electrons arriving at any point on the screen PQ would be simply the sum of the numbers of electrons arriving when each slit is opened in turn. But if electrons are waves, each electron-wave would partly pass through both the slits and the passage of the wave through one slit would be affected by opening or closing of the other slit. When both slits are open, they act as coherent sources of waves and produce an interference pattern on a screen placed on one side of the diaphragm opposite to that of the source. (The number eight mentioned earlier in connection with the count of electrons per second comes from the sum of squares of individual slit counts; $2^2 + 2^2 = 8$). The wavelength of the incident wave can be calculated from the spacing between successive bright fringes, and it agrees with that given by the de Broglie relation.

It is interesting to note that Sir Joseph John Thomson (1856-1940), a British physicist, made the announcement in 1897 of the discovery of electron as a separate particle seen in cathode ray tubes, for which he was awarded the Nobel Prize in 1906. His son, Sir G. P. Thomson, shared the physics Nobel Prize with C. J. Davisson in 1937 for showing the wave character of the electron. The father and the son thus demonstrated two contradictory aspects of the electron.

Philosophical analysis

On first thought the revelation that electrons behave like waves sounds odd. The discovery of electron diffraction in 1927 surprised most physicists, not to speak of the man in the street. It appears all the more baffling that electrons and photons can sometimes behave like waves (in interference and diffraction experiments) and sometimes like particles (in scattering experiments).

To remove the puzzle, we have to analyse each and every word that has been used and look for loopholes in the classical theory of electrons and photons.

First, what is meant by a particle? It is believed that a particle has definite mass, size and shape. If it is kicked, it hurts the person. If it is thrown, it shoud follow a parabolic path under earth's gravity. When it is in motion, it has definite energy and linear momentum at every instant.

Now, what is understood by a wave? A wave is a disturbance in a medium. It is characterized by wavelength, frequency and velocity of propagation. It may or may not carry energy, depending on whether it is a travelling or a standing wave. When a wave travels in a medium, particles of the medium only oscillate about their mean position; it is the undulation or the medium which travels from one point to another. A wave has no definite shape.

In a sense, a particle and a wave are an antithesis of each other. Ideally, a particle is localized in space while a wave is extended in space by its very periodicity. Ideally, there cannot be two or more particles at a point in space-time; however, there can be any number of waves at a point. These are the ideas in our minds associated with the words "particle" and "wave". It may be said that the word "particle" is a set of certain ideas and associations. If an entity is found which does not have all the properties of a particle as defined above, it would not be called a particle. The same thing applies to the word "wave" also.

Once the particle and the wave have been analysed in this manner, the next hurdle is easy to cross. If an entity is found in this universe which has neither purely particle properties nor purely wave properties but has mixed properties such as mass, energy, wavelength, linear momentum, is sometimes localized and sometimes not localized in space, then it could be called neither a wave nor a particle. Something new has been discovered, and for the lack of a better name it is called a 'wave-particle duality'.

There is nothing logically wrong in the phenomenon of wave-particle duality. After all, the definitions of a particle and a wave given earlier are man-made and the mere definition of an entity does not guarantee the existence of the entity. For example, "unicorn" is a mythical animal which is supposed to be a horse with a horn on its forehead. So far as the definition goes there is nothing wrong with it, but it does not ensure the existence of a unicorn. And even if two entities defined by us exist, we have no reason to assume that the existence of a third entity with mixed properties is forbidden.

Once I was visiting the Cheetal Dear Park on the Khatauli-Muzaffarnagar road in Uttar Pradesh along with a group of friends. There, in a cage, we found some small animals which looked rather strange. They looked partly like rats and partly like rabbits, and we could not agree on what they were. After a prolonged debate, we decided to ask some personnel in the park and we were told that they were a cross-breed between a rat and a rabbit! In our conversation, we had tacitly assumed that this world can contain only rats and rabbits. The revelation that a cross-breed can also exist cleared our clouded minds and showed a way towards real understanding.

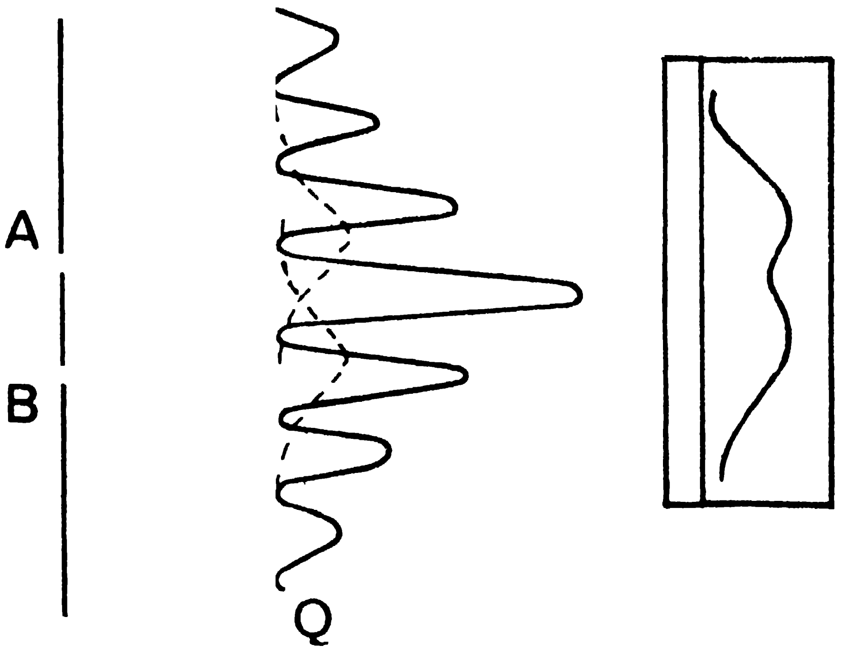

Fig. 2. The full curve shows the intensity of electrons diffracted from a double slit. Dotted lines show intensity distribution when only one slit is open at a time. Box shows intensity distribution according to classical theory, treating electrons as particles This is just the sum of the dotted line distributions

Does every object in this universe, small or large, show the wave-particle duality? In principle, yes. But the wave properties of matter dominate only in the microscopic domain and become negligible in the domain of everyday objects. A simple numerical estimate is of great help in clarifying these concepts. The Planck's constant has the value $h=6 \times 10^{-27}$ erg. sec. An electron has a mass of 9.1×10^{-28} gm. If it is travelling with a speed of about 6×10^{8} cm/sec, its wavelength according to de Broglie relation comes out to be about one Angstrom$=10^{-8}$ cm. This is nearly equal to the spacing between successive atoms in a crystal and therefore the electron is diffracted by the crystal. It should be noted that a wave can be diffracted from a grating only when the wavelength is of the same order as the grating constant. Now consider a small ball of mass one gm. When it is moving with a speed of one cm/sec, the de Broglie wavelength associated with it is about 6×10^{-27} cm, which is much too small in comparison to the grating constant of any artificial or natural grating. Hence its wave nature is totally suppressed and it acts almost like a particle. If it is desired to make the wavelength associated with the ball equal to 10^{-8} cm so that it can be diffracted by a crystal, its velocity would have to be reduced to about 6×10^{-19} cm./sec. If such a ball is initially kept at a distance of one cm from a crystal, it will take about 10^{18}

(*Continued on page* 156)

CHEMICAL INDICATORS THROUGH AGES

Advancements in the development of chemical indicators have contributed much to the progress made in volumetric analysis

S. AKHEEL AHMED

THE word "indicator" is derived from the Latin *indicare*, "to disclose", and might therefore be applied to every reaction or apparatus capable of providing information to the chemist. However, the word is, in analytical chemistry, used in a quite precise and restricted sense. Any titration requires an indicator to show that an equivalent quantity of titrant has been added to the other titrant. This indication can be given in a variety of ways :

(1) It may be a visible (or more generally, perceived by the senses) phenomenon arising naturally at the conclusion of the titration process itself.

(2) It may be some other modification within the titration system which can be made the subject of physical measurement, or

(3) It may be produced by some visible or perceivable change occurring at the equivalence point in some foreign substance. The foreign substance is then called an indicator. Indicators may be used not only to detect end-points but also for quantitative purposes (as in colorimetry) and for qualitative analyses.

Indicators in ancient history

It was no doubt known in ancient times that the extracts of some plants change colour when they are treated with certain substances. However, for the alchemistic classification of their materials this phenomenon was not of importance. It was not until the age of iatrochemistry, also known as medical chemistry (the period of rebirth of natural sciences), when classification of compounds into three main groups, i.e., acids, bases and salts, had begun and those phenomena were examined, and the mechanism whereby a substance changes the colour of an indicator investigated.

Robert Boyle (1627-1691), an English chemist, used plant extracts as indicators in a systematic method of qualitative tests. His work *Experiments on Colours* gives an account of these experiments. As indicators he used extracts of corn flower, cochineal (a bright red colouring matter made from the dried bodies of certain insects), litmus (blue colouring matter extracted from very small plant called lichens that turns red by acid and restores blue by alkali), brazilian-tree, blue-tree (name of the small trees) and curcuma (tuberous plants). It is interesting to note that Boyle attempted to estimate the strengths of acids with

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indicators. He carried out this experiment with blue colour extract of a tree called *Lignum nephriticum*. Later, he described experiments with ammonium hydroxide and urine with which the blue colour of the extract could be restored. The effect of potash on syrup of violets (small flowers having blue-red colour) was examined by him and his findings were that if the material to be tested changes the colour of the syrup to red it shows that acidic salts are in excess, but if the colour turns to green it shows that the material is of opposite nature. Boyle called such materials "alkali salts".

The use of plant extracts as indicators became widespread during the phlogiston period (started at the end of 16th century and lasted for about 100 years) in qualitative analysis. In the more specific field of titrimetric operations W. Lewis (1767), an English chemist, was the first to use litmus as an indicator in the determination of potash. After this, use of indicators for acid-base titrations slowly became accepted.

It was soon observed that various plant indicators do not react uniformly with acids, and that they require different amounts of acid to change their colours in different pH regions. Professor Felice Fontana (1730-1805) in 1775 noted that water containing carbonic acid changes blue litmus to red, but has no effect on the extract of violets. This, in fact, is the method of pH determinations by the use of indicators, but it was more than one hundred years before that this idea became practicabie.

In the field of indicators there was no change for a considerable time. Although a large number of plant extracts were tested, litmus remained in extensive general use. Fredrich Mohr, the German chemist, in his book *Titrimethode* (1855) mentions the extracts of litmus, Pernambuk-tree, camphor tree and curcuma.

The rapid development of organic chemistry, particularly of the dyestuff industry, was soon to produce synthetic dyes with properties similar but superior to the natural dyes.

In 1875, salicylic acid was recommended as an indicator. This gives a violet colour with ferric chloride. The colour disappears in the presence of acids but reappears at the neutralization point. In the presence of alkalis a brownish-yellow colour is observed possibly due to precipitation of slight amounts of iron hydroxide. This method is of interest only because it is the first application of a synthetic compound as an indicator. In fact, the colour change was far inferior to that of the available natural indicators.

The use of fluorescence as an indicator, as fluorescent indicator, began in 1876. This compound emits a fluorescence induced by ordinary light in alkaline medium, but the fluorescence is destroyed by one drop of free acid. Carbon dioxide does not interfere with colour change of the indicator. It could also be used with analysis of coloured or turbid solutions. This indicator did not achieve much success.

Development of acid-base indicators

In 1877, an indicator which received worldwide application was phenolphthalein, but it was rapidly followed by tropeolin and methyl orange introduced by Georg Lunge, the German chemist, in 1878.

In the succeeding years many synthetic organic compounds were recommended for use as acid-base indicators. A paper published by Wilhelm Ostwald, a German chemist, in 1893, mentions 14 synthetic indicators. The colour changes of synthetic indicators differed more markedly than those of natural dyes. This soon led to a difference between acid-sensitive and base-sensitive indicators, and led to the introduction of differential determinations, for example, in the case of polybasic acids.

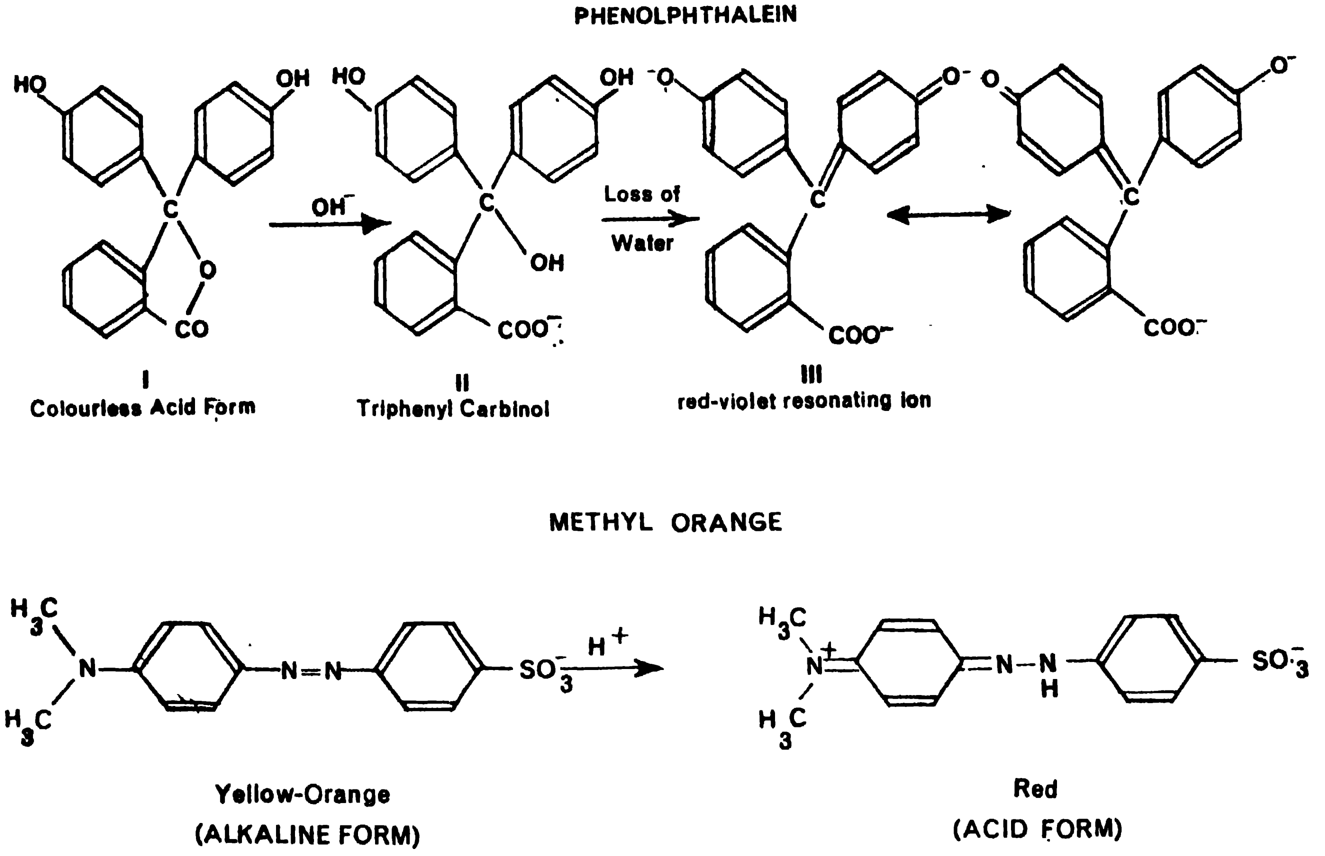
The first theoretical interpretation of the function of acid-base indicators was made, on the basis of the ionic theory, by Ostwald in his book *Die Wissenschaftlichen Grund Lagen Der Analytischen Chemie* (*1894*).

According to Ostwald, if the indicator itself is a weak acid, then other weak acids can give up their hydrogen ions so that the indicator exhibits the colour of the undissociated form. They are therefore acid-sensitive indicators, phenolpthalein for example, where the undissociated indicator is colourless while its ions are coloured. Methyl orange, on the other hand, is a moderately strong acid whose ions are yellow but the undissociated indicator itself is red In solution, it dissociates considerably and shows a mixed colour. When hydrogen ions are added the amount of dissociation decreases and the solution becomes red. A weaker acid, however, contains far fewer hydrogen ions capable of changing the equilibrium when passing through the neutralization point. Methyl orange is therefore more sensitive to bases.

The explanation of Ostwald is plain, simple and understandable. It is this interpretation which made clear and understandable a series of phenomena of chemistry that had hitherto seemed quite incomprehensible. It is probably no exaggeration to say that in both general and analytical chemistry everything appeared to be well ordered in Ostwaldian age; all the phenomena were explained and rationally understood.

Development and innovations in twentieth century

Ostwald's explanation, however, did not last long; various workers observed phenomena which did not agree with Ostwald's theories. One of the earliest problems to


PHENOLPHTHALEIN

METHYL ORANGE

Fig. 1

appear concerned the mechanism of indicator change. It arose when it was observed that the colour change is not instantaneous in many cases. It followed that some change in structure as well as the ion process too occurred. Arthur Rudolf Hantzch, a German chemist (1857-1935), in 1906 proposed his well-known chromophoric theory of indicators which interprets the colour change on the structural organic aspects. The colour change is caused by a structural change in which the inorganic form is evolved from the pseudo one. For example, phenolpthalein and methyl orange undergo structural changes (Fig. 1). This theory was received more favourably than Ostwald's by organic chemists. From analytical point of view it was not favoured, as it did not give an adequate interpretation of the quantitative aspects of the indicator change.

The two theories were reconciled by the contemporary American analytical chemist Izaac Maurits Kolthoff who devised a theory which retained the most useful parts of Ostwald theory. According to Kolthoff, the colour of the indicator is determined by the equilibrium between the pseudo and ionogenic forms as well as by the dissociation equilibrium of the latter. Recently, theoretical organic chemists have tried to interpret the colour change of indicators as being due to mesomeric phenomenon (some molecules, wherein redistribution of electrons is possible and which exist in the most stable or less energy state, are thought to be in mesomeric state). At the end of the last century it seemed as if scientists would give unambiguous answers to most of the major questions.

One of the most commonly used acid-base indicators today, methyl red, was introduced in 1908. Most of the sulphonapthaleins were prepared and introduced in 1915 and by using different sulphonapthaleins it was possible to develop the present colorimetric method for pH determination.

The first fluorescent indicator, fluorescein, was introduced before the dyestuff indicators appeared on the scene. The use of fluorescent indicators, which when illuminated emit fluorescence in alkaline or acid medium, is particularly advantageous when turbid or dark coloured solutions are titrated. Recently

Fredric Kenny, an American chemist, recommended the use of chemiluminescent acid-base indicators. The latter detect the end-point by emission of light. They have an advantage over ordinary fluorescent indicators in that the energy required to produce luminescence is obtained from the chemical reaction itself and not from an external energy source.

Redox indicators

Redox indicators constitute another important class of indicators. Most indicators in this class were developed after the acid-base indicators, particularly after the First World War. The French chemist J. L. Gay-Lussac (1778-1850) determined hypochlorite by titration with arsenious acid with a few drops of indigo solution as an indicator. The end-point was detected by decolourisation of the indigo. The indicator is not reversible in this case.

Chromatometric methods (use of potassium dichromate as an oxidant), although well-known from a very early period, were not widely used owing to lack of suitable indicators. In 1906 diphenylcarbazide was suggested as an indicator for the chromatometric determination of iron (II). This indicator gives a violet colour with an excess of chromate. The first reversible redox indicator was proposed in 1908 which was prepared by heating azobenzene with concentrated sulphuric acid. The molten mixture was then poured into a large volume of water imparting to it a deep red colour. (The name of the indicator is not found in literature, only its preparation is given).

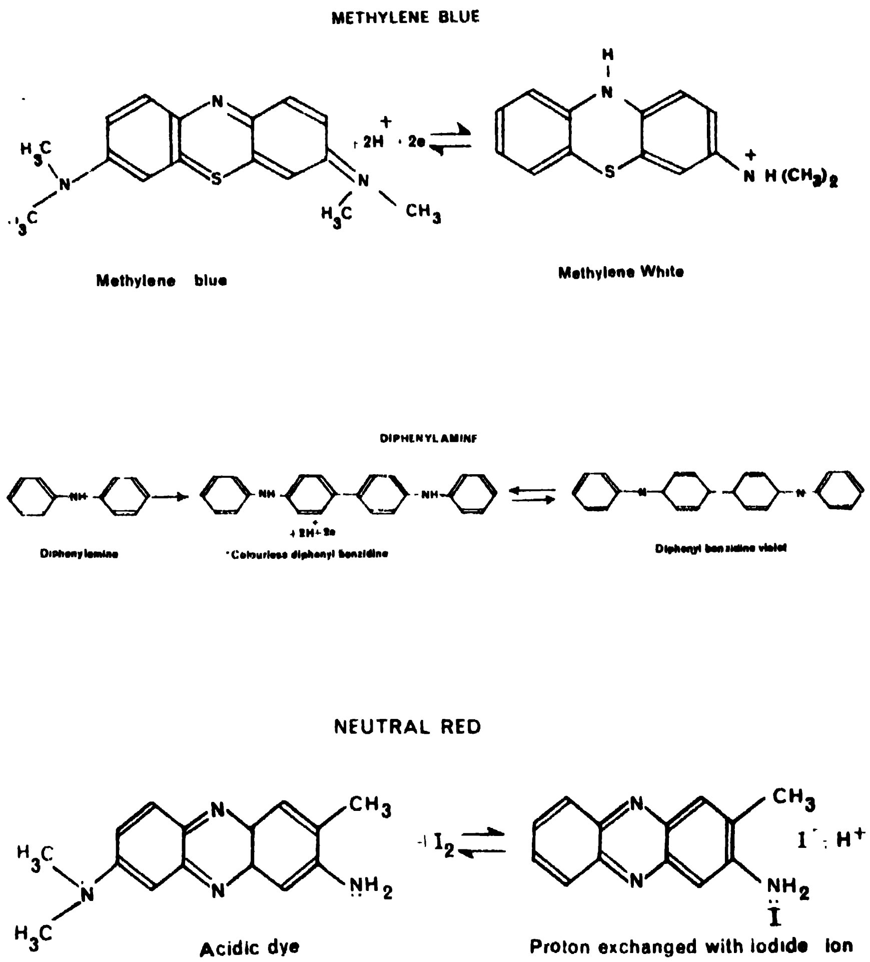
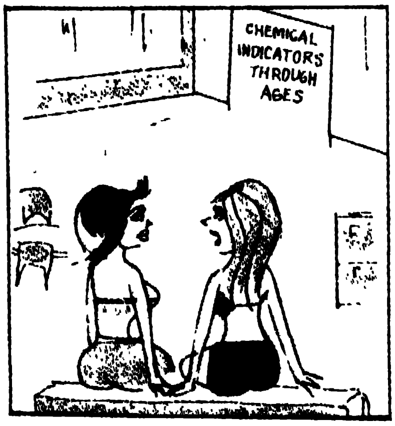


Fig. 2



"But he has assured me that he is not working on chemicals that could indicate our ages."

The first definite redox indicator was diphenylamine introduced by J. Knop, a Czech chemist, in 1925. Knop and his wife Olga Kubelkova, over the next few years, discovered a large number of triaryl methane-type compounds which proved suitable as redox indicators. The mechanism of the redox behaviour of the methylene blue and diphenylamine is given in Fig. 2.

In addition to redox indicators which undergo a colour change, chemiluminescent redox indicators have also been recommended recently; for example, siloxene, luminole and lucigenine. Redox indicators which undergo a colour change, usually function in acid medium. However, the redox reactions which take place in alkaline medium have hitherto been seldom used for analytical purposes. Some of the more recent chemiluminescent indicators have the advantage in that they can also be used in alkaline medium. It is interesting to note that detailed practical and theoretical investigations of redox indicators were also made, not by analysts, but by biochemists and medical workers. Even the term "redox indicator" was coined by a German medico, Leonor Michalis (1875-1949), who is also noted for his important contributions to the theoretical investigations of redox systems and indicators.

Adsorption indicators

The third important group of indicators, adsorption indicators, is a more recent innovation introduced in 1923. The first of them was fluorescein used for argentometric determination of chloride. The mechanism of the action of redox adsorption indicators for the neutral, red indicator is shown in Fig. 2.

This indicator is dependent on the effect of positively charged iodine which shares the mechanism. Accordingly, the proton of the acidic dye is exchanged with a positive iodine ion. The prerequisite of this reaction is, however, the fixation of the iodide component in the solution by converting it into a silver salt. The end-point of the titration appears in the presence of excess silver. In recent years substances have been discovered which act as acid-base, redox and adsorption indicators simultaneously. The first of these multiform indicators was *p*-ethoxy chrisiodine.

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DILEMMA IS : WAVE OR PARTICLE ? (*Continued from page* 151)

secs (about the lifetime of the universe) to reach the crystal. Instead, it is convenient to reduce the mass (that is, the ball is replaced by an electron or an atom) rather than the velocity to bring out the wave nature of matter clearly.

Experiment and observation are the basis of all sciences and the evidence gathered from scientific experiments cannot be overlooked. In the light of the experimental evidence in favour of wave-particle duality the new concept should be accepted without hesitation.

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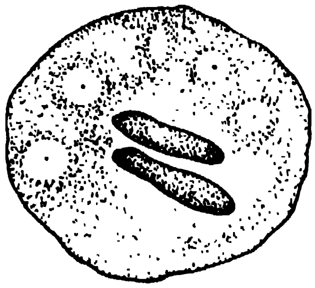
AMOEBIC DYSENTERY

A SERIOUS HEALTH PROBLEM

Intestinal amoebic infection is not only an affliction of the tropical countries, but colder regions of the world too.

SOHAIL AHMED



FOR the first time in 1873 a Russian scientist, Losch F., reported the presence of amoeba-like organisms in the feces of a patient who was having severe dysentery. Subsequently, he established the causal relationship of these organisms with dysentery by demonstrating their disease-producing ability in experimental dogs. The pathogenic potential of these organisms was easily confirmed by carrying out a simple experiment in which the test animals were fed with a small sample of the dysenteric stool obtained from the patient. The infected animals showed the appearance of typical dysenteric symptoms. Later, a German physician Robert Koch and his associate Gaffky in 1887 established the causal relationship of these organisms with the development of intestinal ulcers. The American scientists, Councilman, W.T. and Lafleur, H. A. of the Johns Hopkins Hospital in 1903 made some further contributions to the pathology of amoebic infection and liver abscesses. An article published in the *Phillipine Journal of Science* by Walker, E.L. and Sellards, A.W., provided a detailed account of the pathogenecity of these organisms and also furnished the basis of the present day concept of host-parasite relationship. These experimenters fed the amoebae to human volunteers and demonstrated the relationship between amoebic infection and the appearance of typical amoebic dysentery symptoms. This was a conclusive evidence ever provided in human subjects that clinical symptoms of amoebic dysentery are caused as a result of intestinal amoebic infection. Such studies of the host-parasite relationship are often obligatory for understanding the aggressive mechanisms of the parasite, the defense potentialities of the host and, of course, the final outcome of such an interaction.

The causative organisms

The dysentery causing amoebae can be seen in the feces of a suspected patient under the ordinary light microscope. Three morphological stages in the life cycle of this parasite can be detected in such microscopic stool examinations : (a) the trophozoite—an actively motile, vegetative stage ; (b) The precystic stage—a transitory stage in between the trophozoite and the cyst; and (c) the cystic stage—a nonmotile infective stage having a tough outer coat. This stage is essential for

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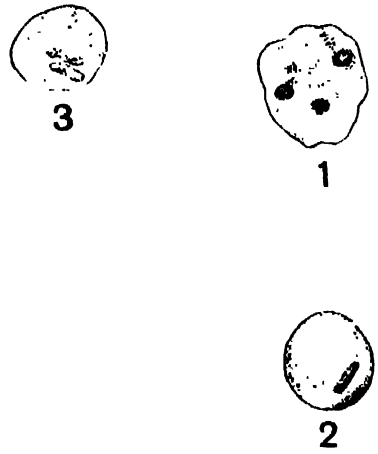

Fig. 1

the extracorporeal existence of the parasite.

The trophic or vegetative forms in microscopic examinations appear as blobs of actively motile organisms. They do not possess a definite shape, consist only of a tiny nucleus which is surrounded by a small amount of everchanging and flowing cytoplasm. The average size of an amoeba trophozoite varies from 15 microns to 40 microns (1 micron is equal to one millionth of a meter). Some other organelles like ectoplasm, endoplasm and the quick-forming feet, or pseudopodia, are easily discernible in a careful microscopic examination. But nucleus which is the most important organelle is not always detectable in ordinary slide preparation. The vegetative forms of the parasite are so fragile that they cannot survive for more than a few minutes outside the body of the host. These trophozoites are also killed by the action of the digestive juices and, as such, do not constitute an infection hazard even if swallowed.

The precystic stages are only of a transitory nature. They are found at the time when the cysts of this tiny parasite are getting ready to go out of the body of the host for the purpose of completing their life cycle. The life cycle is completed only when the cyst is ingested by another human host, usually through fecally-contaminated food and water. The cyst is the final stage in which it leaves the body of the host—for its sojourn into the outside world and to a new host, if possible. It is fully equipped to meet the unfavourable conditions which may be encountered during its hunt for a new host. The cysts are rounded and ovoid, not perfectly symmetrical. They have a tough and thick outer coat to ward off the anti-elements. The cysts also contain a liberal supply of food in the form of chromatoid bodies and glycogen granules. There are four nuclei within a cyst, each of which is capable of multiplying further. The cysts, after reaching the site of infection, release their nuclei by breaking apart the cyst wall. Soon after, each of the four nuclei divides once and doubles its number. Each cyst then releases eight daughter amoebae. The multiplication rate is therefore one to eight for this parasite.

The disease

The disease caused by these potentially pathogenic amoebae may include a wide range of pathogenic conditions or symptoms. A variety of vague, rather indefinite symptoms, often accompanying the amoebic infections are usually referred to as 'amoebiasis'. The symptomatology may often be described as according to the two types of infection ; (a) intestinal infection in which amoebae remain confined to the intestine, and (b) extraintestinal infection in which amoebae run out of the intestine, and colonize other organ systems, usually liver.

The disease producing abilities or the pathogenic mechanisms of amoebae may be regarded as a progressive cellular or lytic digestion (cell damage due to enzymic action of the parasite) of the infected tissue. This tissue-dissolving potential alongwith the ability of the parasite to penetrate mechanically into the cells, is responsible for invasion of the deeper tissue. Besides this, some kind of microbial inter-relationship (the involvement of other normally occurring intestinal bacteria) is believed to be involved not only in the survival of the amoebae but also in the successful establishment of the disease. The disease in its milder form is so innocuous that it may remain unnoticed in a large number of persons. Such symptomless subjects, in microbiological jargon, are referred to as asymptomatic carriers. But contrary to this, the disease in severe cases may even prove fatal. The severity of infection could therefore be anywhere in between the two extremes. A variety of factors like the general body resistance and the nutritional status of the host are some of the determining parameters for the severity of the infection. It has often been recorded that a high carbohydrate diet increases the susceptibility of the host. In typical infections of moderate intensity, the intestinal wall shows the formation of small pock-mark like ulcers as a result of tissue damage in intestinal amoebiasis. Such intestinal lesions due to the colonization of amoebae are commonly seen in a large number of clinical cases. The colonization is a common trait in parasites and in human beings—in fact, all forms of life must necessarily colonize. In more severe cases, the ulceration may be deeper and extend to the surrounding tissue, often causing extensive damage.

In extraintestinal amoebiasis, the organisms generally colonize in liver and other distantly placed organ systems. More often than not, such infections are usually located in liver, a very important and delicate organ. Such amoebic infections in the liver are responsible for causing typical lesions in the liver, usually referred to as amoebic liver abscesses. This form of infection is clinically known as hepatic amoebiasis. Amoebic liver abscesses generally appear as small, necrosed, rounded areas at the site of infection in the liver tissue.

Pathogenecity

The parasite is so well adapted to its natural habitat (the intestine) that sometimes even its disease causing ability appears to be somewhat doubtful. The parasites never really want to ruin the place where they live. Infact, no form of life would like to annihilate its habitat or environment. In some infected inbividuals the parasites remain in more or less perfect harmony with the host — an example of coexistence between forms of life whose aims and objects are obviously so diversified. But once in a while, however, this happy equilibrium is broken and the disease is caused by the parasitic invasion of the tissue. The losing of this particular balance in amoebiasis is somewhat dependent on many important factors such as the condition of the host in respect to the intactness of the gut wall, diet, nutrition, debilitating environmental factors and other acute intestinal disorders. The virulence or the disease potential of the invading amoebae is also an important factor to be considered.

Transmission

Dysentery is transmitted from person to person by the resistant cystic stages of the parasite. The infection is mainly transferred through fecally contaminated food, water and soil. Fecally contaminated objects like door knobs, towels and other objects of common use are also some of the important contact factors in the spread of the disease. The disease is established in a new individual by the ingestion of the cystic stages of the parasite. More frequently, the common source of infection is the ingestion of cysts through fecally contaminated raw vegetables. The food handlers in India constitute the biggest source of transmission of cysts from host to host. Fecal contamination of water, specially in rural areas, where proper water supply facilitie are lacking is

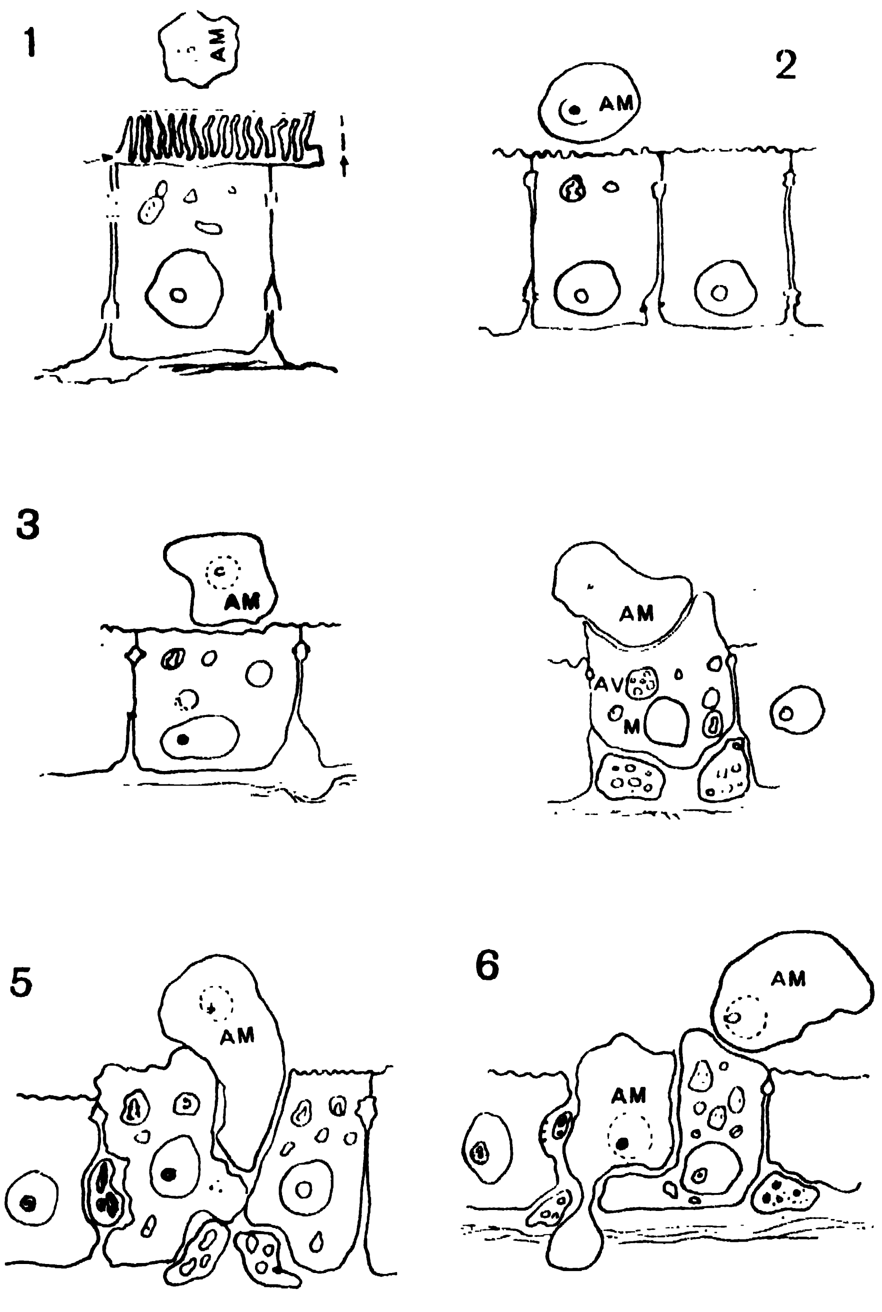

Fig. 2. A scheme based on the results of electron microscopic studies illustrating the penetration of cecal epithelium of guinea pigs AM : Amoeba (*Courtesy* : Akio Takeuchi and Bruce P. Phillips; *Am. J. Trop. Med. Hyg.*, 24: 34, 1975)

perhaps the greatest single source of infection. Transmission through the agency of dust, housefly and other such insects is yet another source of infection. Due care for saving oneself from the possible sources of infection should necessarily include the eating of properly washed vegetables, safe and uncontaminated food and drinking water, care of the food handlers and finally, of course, an arrangement of some sort for proper disposal of human feces.

The incidence

There are widely divergent reports regarding the incidence of the disease in various parts of the world. By and large, such surveys are based on hospital recorded cases, and as such, do not necessarily depict an actual rate of incidence in the local populace. The situation in India as far as these surveys are concerned is no different One such study for determining the incidence of parasitic infection in hospital patients was carried over for a period of seven years in Bankura, West Bengal (Sengupta and Bhattacharya, 1975). These investigators have shown that about 27.3 per cent people were found to carry amoebic infection in a sample survey based on 18,788 cases. This report has also shown an age and sex-wise distribution of the infection. The highest rate of infection (39.9 per cent) was found amongst the males in the age group of 26-45 years. Sex-wise, the report indicates a slightly higher rate of incidence (40 per cent) in females than in males (39.7 per cent). A few other surveys have shown a higher incidence in males possibly due to an increased rate of alcohol consumption. A sero-epedemiological survey, based on the detection of antibodies in the serum of patients attending various out patients departments, was also carried out in the laboratory of the author. Its results have indicated that the prevalence of infection was higher in males belonging to a comparatively lower socio-economic group (monthly earnings Rs. 300/- or less). Areawise, the data break up in quantitative terms showed a higher incidence rate in urban population. Further, the carrier state of the infection was found slightly higher in the people with predominantly vegetarian food habits. The endemicity or the prevalence of the infection in a particular population or area depends on several environmental and biological factors. For example, poor sanitation, fecal contamination of food and water and, the practise of using human refuse as raw manure are some of the contributory factors in the establishment of an endemic community. Climatic conditions like temperature, rainfall and humidity do not really appear to have any correlation with amoebic endemicity. Also, the notion that intestinal amoebic infection is only an affliction of the tropical countries is rather erroneous. The colder regions of the world can also have an equally higher rate of infection. Some biological conditions like malnutrition, lowered body resistances and a stable carbohydrate diet are some of the factors increasing individual susceptibility to the infection.

Immunity

No well defined and effective body defenses, like the ones which protect the body against cholera and typhoid, are known to exist against amoebic dysentery. Reinfections and superinfections are common. Both the immune and nonimmune subjects keep getting the infection as long as the source of infection is intact. Though some cases of acute amoebic liver abscesses often rarely show a second infection. But milder infections are no safeguard against subsequent attacks. The reasons for not having a well defined protective immunity, as evidenced in other diseases, are not too well-known. Nevertheless, the possibility of enhancing the body resistances and obtaining a successful immune protection should not be taken as a lost cause. Recently, a few amoebiasis research workers have reported some partial success along these lines.

Effectiveness of various drugs

The amoebic cysts can be killed by a concentration of 1/2500 parts of mercuric chloride. Other cysticidal agents which can be effectively used for decontaminating purposes include 1 per cent phenol, 5 per cent formalin and 0.3 parts/million ozone. About 1 per cent potassium permanganate, which is commonly used for decontaminating water and raw vegetables, has been found ineffective against amoebic cysts. Chlorination of water and washing the vegetables with chlorine solution are quite effective for preventing an infection. Cooking utensils and other kitchenware can be easily decontaminated by washing with a large number of commercially available cationic detergents.

Therapeutically, sulfonamides (sulfa drugs) and antibiotics (the compounds usually effective against a large number of disease-causing agents) are ineffective against amoebic infections. Streptomycin (also an antibiotic) has been reported to reduce the rate of multiplication of amoebae, but such a treatment generally prolongs the survival rate of amoebae by inhibiting the normally occurring bacteria of the intestine. Moreover, such a treatment generally disturbs the healthy microbial balances within the intestine. Emetin, vioform and preparations containing para-aminobenzoic acid are some of the common amoebistatic (controlling) agents. As a result of a combined effort of a large number of laboratories around the world, a few more effective drugs against amoebic infections have recently been developed from certain metronidazole compounds. The inhibitory effects or effectiveness of some of these drugs have also been tested in India by Dr. U. K. Sheth of Clinical Pharmacology Unit, Seth G. S. Medical College, Bombay. He has reported that metronidazole and its other commercially available derivatives are quite effective drugs, possessing a considerably high chemotherapeutic activity against amoebic infections.

But a word of caution would not be out of place ; that all such drugs have a certain amount of residual toxicity. The golden rule for amoebic dysentery should, therefore, also be gleaned in the light of the old saying—'prevention is better than cure'.

Further reading

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BATTERY ELIMINATOR (*Continued from page 197*)

somewhat less. Incidentally, you can also go in for the circuit that is given right at the beginning. Instead of BY 127, use a two pin rectifier (selenium). The cost will come down by about Rs. 5 and you will still get quite a satisfactory result. In this case, you don't have to use the choke or the toggle switch.

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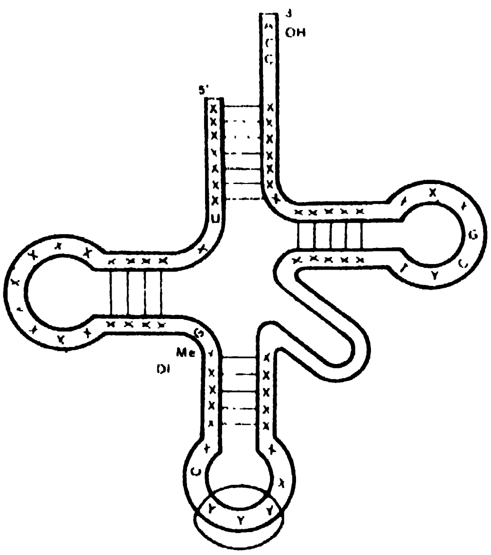
Corrigendum

Ref. S. R., Jan. 1977, page 35 *read* feature title as "Electrogrophic Analyser" Page 36, the dimension of the handle of spiral hand in the diagram is 5.5 cm.

By chemical synthesis of a biologically active gene, now made possible, a molecular geneticist can fabricate any DNA sequence he wants



Can MAN make a GENE?

SUBHASH S. ARORA
KAREN SANSI

EVERY organism on the earth has the ability to maintain its individuality and to produce offspring of the same kind. This self-preservation and self-reproduction depends on the presence and arrangement of various but essentially three types of giant molecules. They are polysaccharides, proteins, and nucleic acids (deoxyribonucleic acid, DNA; and ribonucleic acid, RNA).

The polysaccharides and their derivatives are used for maintenance and reproduction. These substances serve only to prolong the life span. Some viruses do not contain polysaccharides at all and are composed entirely of proteins and nucleic acids. Such viruses under appropriate conditions can reproduce, showing the lesser importance of polysaccharides. The proteins, on the other hand, play a more integral role in structure, maintenance and reproduction. Moreover, the uniqueness of each kind of organism is associated with a unique set of protein molecules it contains. Proteins are essential building blocks of membranes. They maintain the physical integrity of organisms. They are also enzymes which catalyse metabolic reactions. Therefore, protein molecules are important and play an important part in the bodies of plants and animals so much so that all organisms contain protein molecules.

The structure and metabolic activities of a cell are organized for its preservation. For this, the protein components are continually destroyed and replaced throughout the cell's existence. Consequently, organisms must possess the instructions for producing more proteins of correct kinds and quantities. It is equally important that these should be produced at the correct time and place. Such instructions should not only be preserved and replicated but also be transmitted to and maintained in its offspring. This type of information is contained in the genetic material. Which, then, is the genetic material—proteins, nucleic acids or both? Because of their simple

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chemical make up, viruses and bacteria were used for this study.

The experiments of F. Griffith of England in 1927 suggested that only DNA is the genetic material of the bacterium, *Diplococcus pneumoniae*. That the genetic material of T_2 virus is DNA was proved almost conclusively by the experiments performed by A.D. Hershey and H. Chase in 1952 at the Carnegie Institution, USA. Fraenkel Conart and his colleagues in 1958 at Virus Laboratory in Berkeley, University of California, proved that it is RNA that carries genetic information in tobacco mosaic virus (TMV). It is now certain that the genetic information of higher organisms is stored in DNA. It is now obvious that DNAand RNA contain the genetic information of almost all organisms and not the proteins (Fig. 1). However, the information for the structure and synthesis of polypeptides (or proteins) is stored in the polynucleotide chains (DNA or RNA).

DNA structure

The nucleic acid DNA is a substance that carries information from generation to generation. It is a long, double-stranded macromolecule. The two strands are coiled helically around each other forming a double helix. Each strand is made up of a chain of four kinds of nucleotides. A nucleotide is a complex structure composed of a phosphate group attached to a 5-carbon deoxyribose sugar linked to one of four different bases (Fig. 2). In a nucleotide the phosphate molecule can be linked with sugar molecule eitner at carbon number 5 or at carbon number 3. The former is known as 5'p3'OH nucleotide and the later 3'p5'OH nucleotide. Successive nucleotides can unite forming a phosphodiester bond between them to give rise to a polynucleotide chain. A polynucleotide chain written as 5'p3'OH would mean that there is a phosphate group at carbon number 5 at one end of the chain and at the opposite end there is —OH group at carbon number 3.

The bases are adenine (A), guanine (G), cytosine (C) and thymine (T). First two bases are purines and the last two pyrimidines. The purines and pyrimidines are nitrogen-containing closed ring organic compounds. The bases A and T, and G and C are "complementary bases" because for every A in one strand there is a T in the other and for every G there is a C in the other. This is called the complementary base pairing and sometimes termed as Watson-Crick pairing after its discoverers. Therefore, in double-stranded DNA the number of A molecules is equal to the number of T molecules and similarly G equals C. The complementary bases are bonded together by weak chemical bonds known as hydrogen bonds. These bonds keep the two polynucleotide chains together running in opposite directions and impart stability to the DNA molecule. The sequence of four kinds of bases on the long sugar-phosphate chains determines the biological properties of the molecule.

DNA of different species is distinguished by the relative number of AT and GC pairs and by their specific sequence. In fact each species of the living world is distinctive just by such qualitative and quantitative differences. A particular nucleotide sequence or a segment of DNA responsible for synthesis of a particular protein is known as gene.

Gene

Genes are the particulate determiners of a heredity trait. Genes of all organisms are made solely of DNA (with the exception of a few organisms in which they are of RNA). DNA, therefore, is rightly regarded as the primary "store house" of genetic information. The discrete segments of DNA which contain genetic information for the structure and production of proteins are known as genes. The specific proteins require specific lengths of the nucleotides and hence different genes. Different genes determine the structure of different RNA molecules, which in turn, produce different proteins. In living cells, only one strand ("sense strand") of DNA serves as a template along which the nucleotides of RNA are lined up according to the complementary rules to form RNAs (Fig. 3).

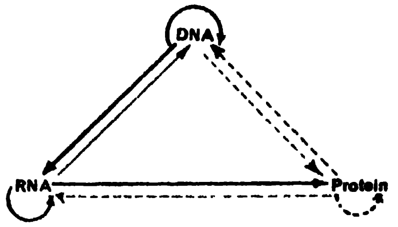

Fig. 1. Diagram of relationship between DNA, RNA and protein. The heavy lines indicate the known directions of transfer of information in cells. The thin lines indicate special information transfer machanisms. The dashed lines indicate directions of information transfer not yet demonstrated. (After Crick, 1970, *Nature*, 227, 561-563)

"The intelligence genes they have developed can only stimulate natural but dormant intelligence genes. So it cannot be of much help to you."

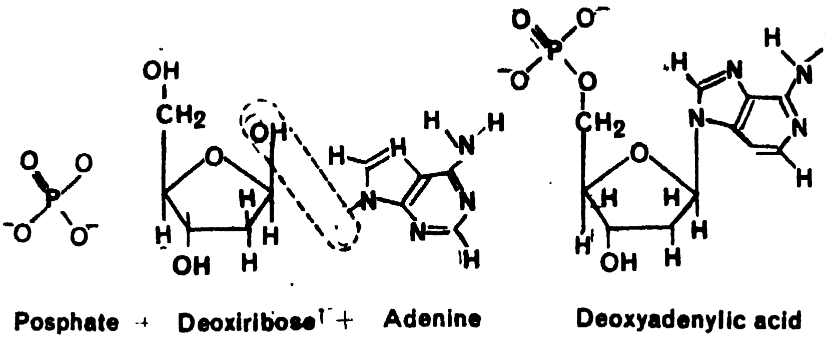

Fig. 2. Formation of the (deoxyribo) nucleotide

RNA structure

The second nucleic acid, RNA, occurs in multiple forms in the cells, each having an extremely important role. There are three kinds of RNAs which are classified according to their metabolic roles. The three classes are; messenger RNA (*m*RNA), ribosomal RNA (*r*RNA) and transfer RNA (*t*RNA). Each of these serves as an informational link between DNA and proteins. Specifically, the synthesis of *m*RNA on DNA template is called "transcription" and the synthesis of proteins from messenger RNA is called "translation". The sequence of nucleotides in *m*RNA determines the sequence of amino acids to be incorporated in the protein molecule (translation). RNAs have base composition very closely related to DNA. However, they differ from DNA in the following important ways: (1) Molecules of RNA are single-stranded, linear polymers of mononucleotides. Although certain types partially assume a secondary double-helix configuration through complementary base pairing; (2) The sugar of the sugar-phosphate strand is ribose; (3) Nucleotide bases are the purine—adenine (A) and guanine (G);and the pyrimidines—cytosine (C) and uracil (U). The last replacing the thymine (T) of DNA; and (4) *t*RNA has "unusual" bases which are the known enzymatic modifications of A, G, U and C (Fig. 4).

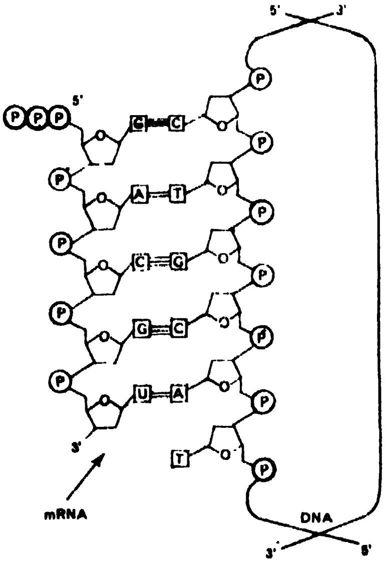

Fig. 3. Transcription of *m*RNA from the template strand of DNA showing that *m*RNA is complementary to the template DNA strand. Note that in *m*RNA there is U instead of T

The role of *m*RNA is to act as template upon which amino acids are lined up for the formation of protein. *m*RNA comprises about 5–10% of the total RNA of a cell. The role of *r*RNA is probably structural. It forms a skeleton for the assembly of ribosomes during the protein synthesis. It make up about 75–80% of the total RNA of a cell. *t*RNA consists of different species. They are a group of smallest RNAs that in some way act as interpreters of genetic information. In fact, *t*RNAs are the specific carriers of activated amino acids to specific sites on the protein synthesizing templates (*m*RNA). All these types of RNAs are produced on different DNA sequences. In other words, each kind of RNA has its specific gene. It was the gene coding for a specific *t*RNA which was first artificially synthesized by H.G. Khorana and his colleagues at the University of Wisconsin in Madison, USA.

Gene synthesis

For the artificial synthesis of a gene it is very important that it should be small and its base sequence should be known. It is difficult to synthesize an average gene as it is too long (about 1500–2000 or more nucleotide pairs) and its nucleotide sequence is too difficult to be known. However, the genes coding for *t*RNAs are reasonably small and the base sequences of about 60 *t*RNA species are known. Once the structure of *t*RNA mo-

Applications

THE applications of recent developments in genetic engineering are many. The most powerful use would, however, be fabrication of control sequences to find out how they work. By chemical synthesis of a biologically active gene now made possible, a molecular geneticist can fabricate any DNA sequence he wants. And recombinant DNA technology allows cloning of the synthesized DNA to make unlimited amounts. Insertion to any piece of DNA then follows. There are important applications in studying the structure and function of genes. But it may, however, also lead to real application in the production of insulin by *Escherichia coli*, for example.

Z. I.

lecule is known, it is easy to decipher the structure of its gene. Since *t*RNA molecule has been transcribed directly from the "sense" strand of DNA, it must be complementary to it (DNA). Then the other DNA strand would have the same sequence as *t*RNA but having T instead of U (Fig. 3). So the base sequence of the two DNA strands or a gene coding for *t*RNA is known by knowing the base sequence of *t*RNA itself. Therefore, for the synthesis of gene only known bases are to be stacked together as inferred from its product.

H.G. Khorana and his colleagues, while at Wisconsin, succeeded in synthesizing the gene for yeast alanine-*t*RNA which needed only 77 base pairs. At that time (1965), this gene was the only possible choice as it was the gene whose base sequence was known. Khorana's group exploited the inherent ability of polynucleotide chains to form double-helical complexes by complementary base pairing. It was hoped that the short, single-stranded chemically synthesized segments of DNA, which are complementary to each other, would be enzymatically joined together to form long double-stranded DNA specifying yeast alanine *t*RNA gene.

The chemical synthesis of the segments for alanine-*t*RNA gene was done by stepwise condensation between the hydroxyl group at the $3'$ position of the first or receiving nucleotide and phosphate group at the $5'$ position of the second or incoming nucleotide. All other functional groups of the nucleotides which were not taking part in the condensation were protected. This way di-, tri- and higher polynucleotides of specified nucleotides were synthesized to give rise to small deoxyribonucleotide chains ranging from 5-20 nucleotides (Fig. 5).

The general plan of procedure comprised the following three crucial operations:

1. *Chemical synthesis* of overlapping deoxyribonucleotide segments representing the entire two strands of DNA chain;

2. *Phosphorylation* of the $5'$-OH group of each segment with γ-(^{32}P)-ATP and with an enzyme, polynucleotide kinase. It made the

Motile genes

GENES were so far known to be non-motile structures with fixed and specific positions on chromosomes. They drift from their specific sites at the time of mutation or recombinations. The view that genes are stable is changing rapidly, for in recent years it has been established that genes also move with frequencies as great as 10^{-2}. This was particularly noticed in bacteria, though there are evidences of this character of genes in higher organisms also.

The genes and segments of DNA change their positions on the same chromosome, and also move from one chromosome to another, or from chromosome to viruses and plasmids. These moving genes are categorised into two groups: the insertion elements and antibiotic resistance elements. Under the first group, short DNA segments, nearly the size of the genes, move and change off the expression of that block of genes to which they are transferred. The antibiotic resistance element or the larger segments of DNA of the genes which resist antibiotics also change their position. They are transferred from one plasmid to another and from plasmid to virus, to bacterial DNA also. They also turn off the gene expression.

The two types are quite similar in characters as both are specific in nature and both turn off the gene expression. In some cases they are also structurally related.

It is believed that these moving genes or "jumping genes" also play some important role in shaping genetic behaviour of the organism, i.e., insertion elements are required for chromosomal gene transfer during bacterial reproduction.

Bacterial pathógeneticity is increased due to presence of antibiotic resistance element. Plasmids and viruses are modes of transfer of these elements among the bacteria. F. Hefron and S. Fallow of Washington University (*Science*, 193: 4251, 1976) have observed that these elements move from benign plasmid to plasmids having toxin-containing genes. When bacteria pick up such genes, antibiotic resistance genes are also transferred alongwith. Meningitis bacterium, *Haemophilus influenzae*, has developed resistance to ampicillin and tetracycline.

Both elements function as "regular switches" also, as they turn off and turn on the gene expressions. They are believed to have some role in bacterial metabolism.

Presence of this phenomenon in higher organism is supported by both structural and genetic evidences. In *Drosophila* it was observed that there were sudden deletions and rearrangements of chromosomal segments, turning off and on the gene expression. Barbara Maclintock of Cold Spring Harbour, New York, who studied movement of DNA segments in corn, observed that movement is sporadic and may be identified by the change in gene expression.

These moving DNA segments may have a role in development of cells and their transformation to viruses.

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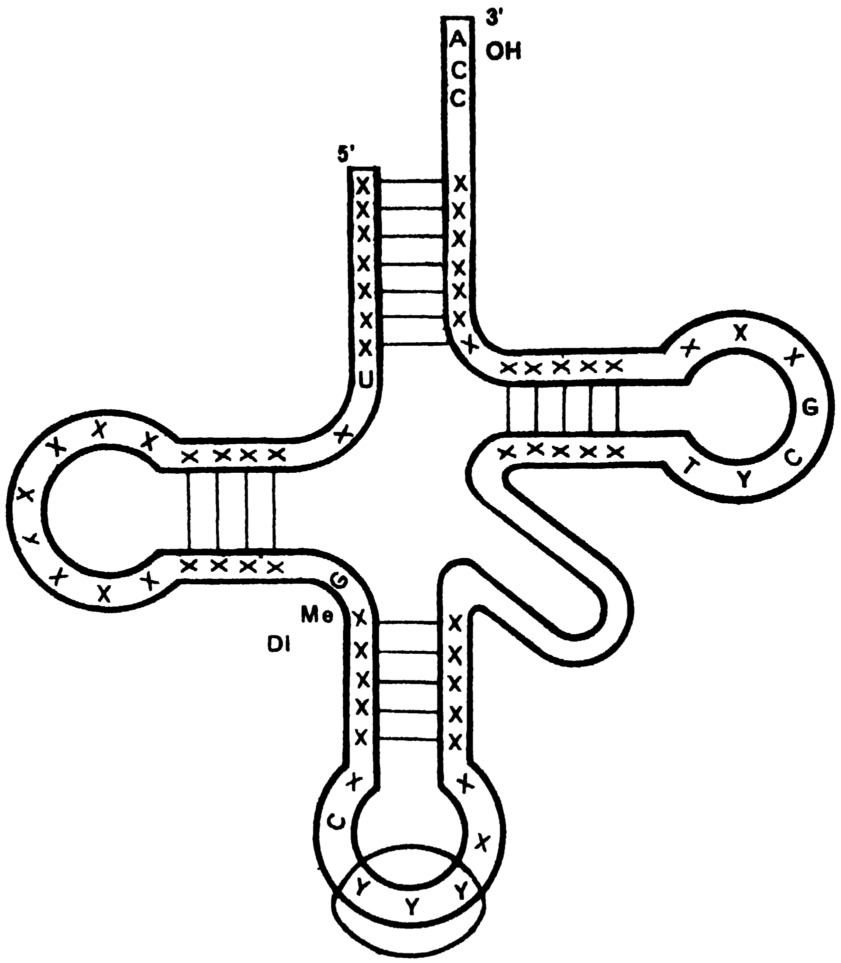

Fig. 4. Generalized two-dimensional cloverleaf model of tRNA, A = adenosine, C = cytidine, G = guanosine, T = ribothymidine, U = uridine, U = pseudouridine, DiMeG = dimethylguanosine, Y = any base of the anticodon, X = any other base

5'-OH group radioactive and therefore enabled the joining of the segments to be checked., and

3. *Ligase joining* of the aligned segments. The head-to-tail joining of the appropriate segments when they are aligned to form bihelical complexes is accomplished by using the enzyme polynucleotide ligase.

It was first decided to synthesize deoxypolynucleotide segments of unequal lengths of the range of 8 to 12 units only. The segments would represent the entire two strands of the specified DNA. When the complementary segments of unequal lengths were placed in solution they formed a two-stranded complex with the larger strand extending out. The extended segment or single-stranded DNA then helped bind the newly added adjacent segment of the complementary strand. Part of the newly added segment then as a single strand helped binding of another segment, and so on.

The detailed procedure for the chemical synthesis or operation 1 depended on the following steps: (a) chemical synthesis of small, single-stranded DNA segments, (b) synthesis of three, double-stranded DNA segments, and (c) synthesis of gene from double stranded DNA segments.

(a) It required the solution of two problems; the first was to develop a suitable protecting group each for 3'-OH, 5'-OH, the amino group of bases, and for the phosphate group itself. A protecting group was looked for with the capability for easy addition and removal under mild conditions.

(i) It was found that the amino groups of different bases required different protective groups (Fig. 5). The amino group of adenine was protected by Benzoyl (Bz) group, the amino group of cytosine was protected by Anisoyl (An) group and the amino group of guanine was protected by Isobutyryl (iB) group. All these different protective groups could be removed easily at the end of synthesis by treatment with ammonia.

(ii) The 5'-OH group of the first or receiving nucleotide was protected by monomethoxytrityl (MMTr) group. It could be removed easily by the action of mild acid.

(iii) The 3'-OH group of the next or incoming nucleotide was protected by acetyl (Ac) group. This group could be easily removed by treatment with alkali.

The second problem was to find an agent for chemical activation of the phosphate group of the mononucleotides. It was to make a phosphodiester or internucleotide bond in between receiving or first nucleotide and incoming or second nucleotide (condensation). Different condensing agents which could be used were mesitylene sulphonyl chloride (MS), dicyclohexyl carbodiimide (DCC), etc.

The two protected nucleotides were then allowed to get condensed under the influence of condensing agent. After each condensation protected 3'-end of the receiving group was made free so that, in turn, it could receive another incoming nucleotide. This way 15 small-single stranded segments of deoxyribonucleotide chains of the size of 5 to 20 nucleotides were synthesized.

The chemically synthesized segments were then labelled or phosphorylated at the 5'-termini using γ-(^{32}p)- ATP (operation 2). This enabled the joining of the segments to be monitored.

(b) These 15 single-stranded oligonucleotides were allowed to form three large DNA duplexes by the complementary base pairing. Thus the gene was divided into three parts A, B and C and each part consisted of several single-stranded segments. Each DNA duplex had at least one unpaired end (or the overlapping end). The overlapping ends help them pair up with each other. These three parts had their individual characteristics as given below:

Part A. This DNA duplex contained first 20 nucleotides with the nucleotides 17 to 20 as single-stranded. It was made with the help of ligase by joining (operation 3) 4 single-stranded DNA fragments.

Part B. This DNA duplex contained nucleotide residues 17 to 50 with two single stranded regions, i.e., 17 to 20 and 46 to 50. It was made with the help of ligase by joining 5 single-stranded DNA fragments.

Part C. It is composed of the rest of the 46 to 77 nucleotides with only one single-stranded region of 46 to 50. It was made with the help of ligase by joining (operation 3) 6 single-stranded DNA fragments.

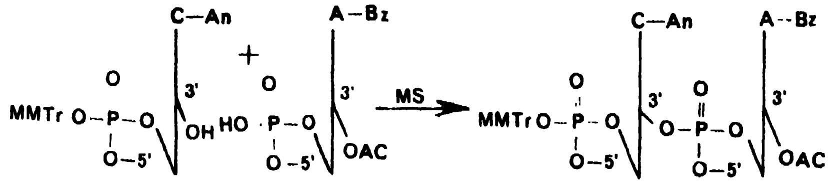

Fig. 5. The chemical synthesis of the di, tri and higher specified polynucleotides. Note that all functional groups not taking part are protected and condensation is brought about by a condensing agent

Ligase joining in each case was checked by esterification of the 5′-(^{32}P) termini in internucleotides linkage. Joining renders the ^{32}P insusceptible to the action of enzyme phosphomonoesterase and phosphatase.

(c) Because of certain reasons, it was decided that part B should be added to part C. After giving them enough time to pair up, ligase enzyme was added and the joining was carried out. Then the preformed B+C was brought into action with A. Ligase was again added and joining allowed to proceed. The correct head-to-tail joining was checked. This resulted in the synthesis of alanine-*t*RNA gene (Fig. 6).

The choice of the synthesis of alanine-*t*RNA gene proved unfruitful as it was nonfunctional both in cells as well as in test tube experiments. It was because of the fact that it did not contain the initiator and terminator signals that are necessary for its functioning. These signals are attached to both ends of the gene.

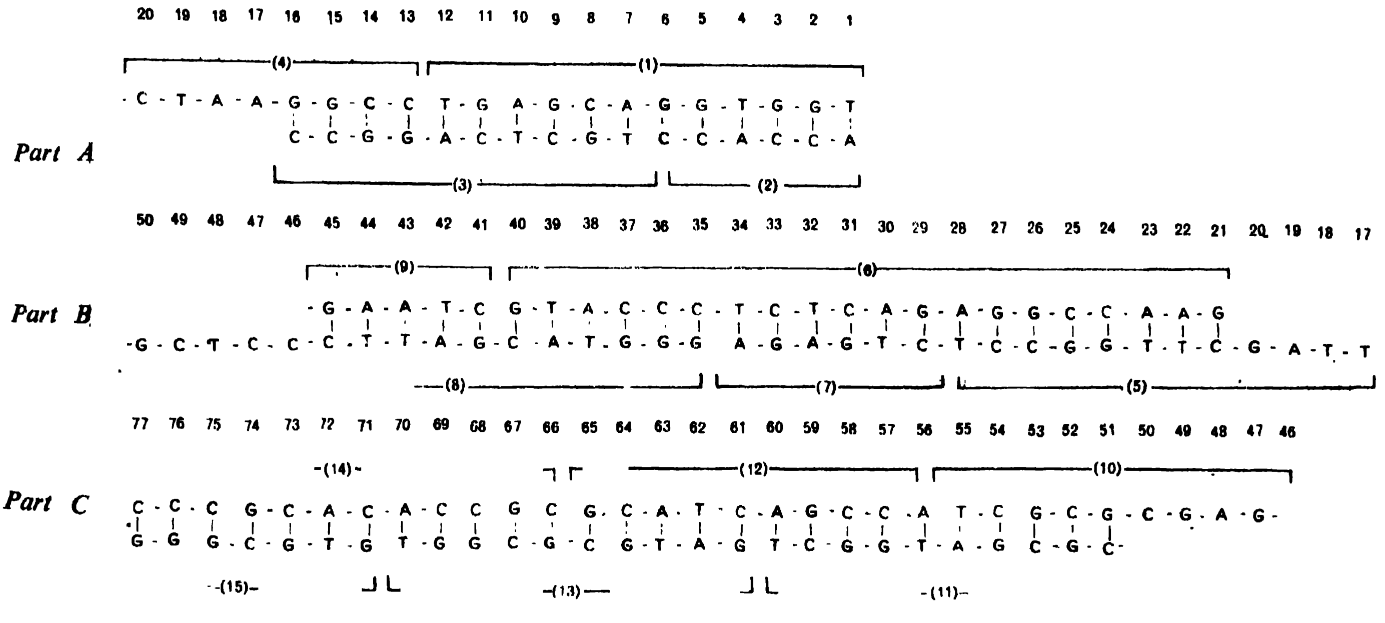

Fig. 6. A plan for the total synthesis of the DNA duplex corresponding to the yeast alanine *t*RNA gene

After this Khorana and his associates in 1973, now at Massachusetts Institute of Technology, completed the synthesis of another gene coding for tyrosine-*t*RNA of a bacterium *E. coli.* This gene was first sequenced in 1968 by John Smith's group at the Medical Research Council, Cambridge. The gene was synthesized in the form of four major sub-units. These 4 subunits were then combined to produce the gene. This was essentially the same procedure that was earlier used to synthesize the yeast alanine-*t*RNA gene. However, at this stage this gene also could not be shown working as it lacked the initiator and terminator segments.

Very recently, the Khorana's group has announced at the Centennial Meeting of the Americal Chemical Society that they have synthesized a complete gene. It codes for tyrosine-*t*RNA that functions in a living cell. This synthetic gene, when inserted into the bacteriophage lambda, has been shown to correct its mutational defects. A mutant strain of bacteriophage lambda when allowed to infect the bacterium *E. coli* produces short, nonfunctional proteins. As a result the mutant normally does not proliferate in the host cell. But when the normal synthetic gene was incorporated into the mutant, it proliferated well like the normal. This showed that the functional proteins were being produced and that the gene was completely normal and functioning.

According to Khorana, the chemical synthesis of a gene is a versatile technique. It enables the study of the effect of mutations and tells about the mechanism of gene control. It is expected that in near future the technique will help us to study why genes in cancer cells appear to be out of control. Other suggestion is, by incorporating a synthetic gene for insulin in a bacterium, it would be easy to produce this protein in large quantities from bacterium instead of from animals. Even the genetic diseases could also be treated by substituting healthy man-made genes for the "sick" ones. This assembly of the artificially synthesized or isolated genes into the chromosomes and the application of this to human problems have been known as "genetic engineering" (*S.R.*, June 1976).

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WILD LIFE (*Continued from page* 147)

to Africa which shelters lions. The great Indian rhinoceros, confined to Assam is the only one of its kind in the world. Several primate sare found no where else except India, particularly the Nilgiri langur, the lion-tailed macaque and the golden langur. Wild cats found in India and not in Africa are the Pallas cat, Indian leopard cat, Golden cat, Rusty-spotted cat, Fishing cat, marbled cat, and snow leopards. The prize attraction of the Indian jungle is the tiger which is not found in Africa.

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SCIENCE SPECTRUM

How strong materials can be

MATERIALS for different engineering applications, say, for building strong and low-cost houses, for making non-corrosive household utensils, for making bio-materials for heart transplant, for making good, semi-permeable membranes for use in desalination of sea water by reverse osmosis, for making temperature-resistant materials needed for engine parts and turbine blades, for making creep and fatigue-resistant materials for aerospace and other applications, for making materials for light-weight batteries and solar cells, for making materials in several sophisticated applications like faster and denser computer memories, etc., are selected on the basis of their different properties. Recent studies have shown that it is possible to vary the properties of materials which in turn have given rise to new applications. This has resulted in a new area of search—search for new materials with new properties.

A search for new materials must start with finding reasons for different properties; the theoretical limit to the values of properties that the materials can have, why the actual materials do not exhibit the different properties up to the theoretical limit and what can be done to improve the material properties to reach the theoretical limit. The material properties of interest can be broadly classified as mechanical, thermal, magnetic, electrical, electronic and optical. In this article, we will deal with the mechanical properties and see how strong materials can be, why actual materials are weak, and how the different strengths can be imparted to materials.

Characteristics of strong materials

Strong materials are characterised by high yield strength, high fracture strength, high fatigue strength and high creep strength. All materials obey a simple law called Hooke's law which states that the stress applied to a body is directly proportional to the strain produced in it within a certain limit called the limit of elasticity. Any deformation produced within this elastic limit is removed when the deforming force is removed. If the stress exceeds the elastic limit, the material does not completely recover its original shape and it is said to become plastic. Normal materials can be strained up to 2% without Hooke's law being violated. We can say that the stress at this elastic limit is a measure of the strength of solids and may be used to calculate the various strengths on this basis. We know that matter is made of atoms and in the solid state these atoms are bound together by some sort of bonding forces. Elastic forces have their origin in these inter-atomic forces due to the different bondings. Knowing the bond strength, it is possible to calculate the stress at the elastic limit. In the case of a body subjected to a longitudinal stress or a tensile stress, an atomistic calculation shows that the yield strength of a solid is about $E/10$ where 'E' is called the Young's modulus of the solid. Young's modulus is the constant ratio formed by the linear stress to the linear strain produced in the solid. When the deforming force is such as to change the shape of a body without changing the size, the body is said to be subjected to a shear stress. For example, when a tangential force is applied at the top layer of a pack of cards held in the hand, the section changes from a rectangle to a parallelogram of the same area. The ratio of the shear stress to the shear strain is called the shear modulus 'G'. An atomistic calculation shows that the shear strength of solids is about $G/6$. This theory does not allow any creep of the material with the passage of time or any fatiguing effect under the action of alternating stresses, so long as the maximum stress at any instant is within the elastic limit.

Actual materials are really weak!

Experiments conducted for the determination of the various strengths of actual materials tell a different story. It is found that crystals

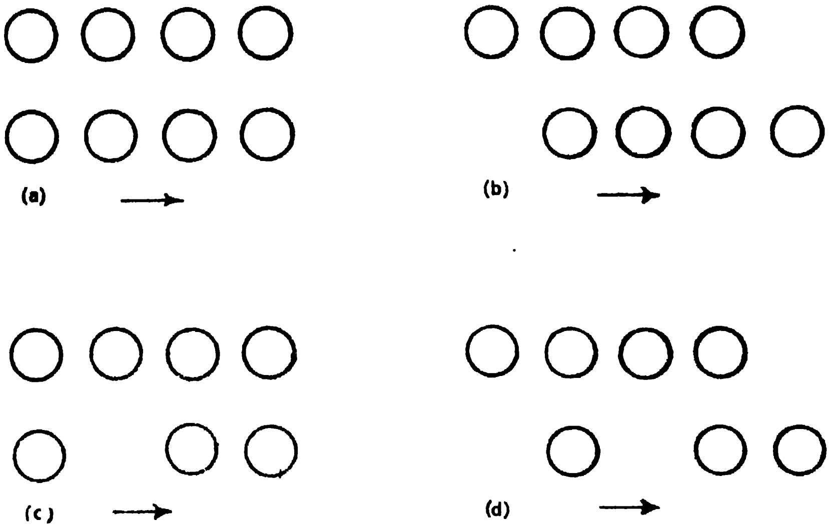

Fig. 1

yield or plastically get deformed at stresses 1/1000 of the theoretical value The same is the story with shear strength. Apart from this, materials which are subjected to cyclic or alternating stresses yield suddenly even when the maximum stress is well within the elastic limit. That is, we say, materials get fatigued and fail because of ageing. Again, materials show viscous behaviour even within the elastic limit especially at high temperatures and give rise to a time-dependent deformation called creep, ultimately leading to catastrophic failures. Sometimes fractures occur suddenly without any prior indication. A fracture is the separation of a solid into two or more parts. There are two important types of fractures, namely, ductile fracture and brittle fracture. Such fractures occur even when the material is worked well within the elastic limit. When the fracture occurs within the elastic limit, it is called brittle fracture. Glass is highly susceptible to brittle fracture. When fracture occurs in the plastic flow region, it is called ductile fracture. In all cases fracture occurs rather suddenly.

Scientists studying the problem of weakness in materials were really puzzled to find such a wide discrepancy between the theoretical and the practical values. All the macroscopic approach they made by extending the theory of strains to large values could not offer any satisfactory explanation. It was soon realised that only a microscopic approach can give a clue to this problem and hence people turned their attention to the atomistic picture of materials.

Microscopic picture of an yielding crystal. The Fig. 1a represents two layers of atoms in a crystalline array under equilibrium conditions. Let the two layers be subjected to a shear stress. Any shear stress which displaces one row of atoms to less than half the inter-atomic distance will produce only an elastic deformation. That is, when the shear stress is removed the atoms will fall back to their original positions as shown in Fig. 1a. But if the shear stress is large, one layer of atoms may be displaced from the other by one lattice distance and fall into the equilibrium position as shown in the Fig. 1b. When the shear stress is removed, the atoms do not come back to the position shown in the figure (1a), but remain in their newly displaced positions as shown in the figure (1b). Obviously, the shear stress has exceeded the shear strength. It is on this picture that we calculated the shear strength of crystals as G/6. Let us consider another picture of the atomic array as shown in the figure (1c), as proposed by Frenkel and others. In this picture we see that there is a vacancy in the second row and we call this a crystal defect. If in such a crystal we apply a shear, we find that the crystal suffers a plastic deformation for a much smaller stress and the atoms take up the new positions as shown in the figure (1d). So we find that the defective crystals yield at much lower stresses than perfect crystals. In the case of perfect crystals the deformation takes place by the simultaneous slipping of all atoms in the row which slips. But in the case of defect crystals, deformation occurs by the simultaneous slipping of fewer atoms. In fact, the deformation of the defect crystal can be pictured as if it is caused by the movement of the defect rather than by the movement of the atoms. By working out the dynamics of dislocation motion or the defect motion it has been theoretically proved that a smaller stress is required to move the dislocation through a layer of atoms than to move the atoms along a perfect array. Let us illustrate this point by a homely analogy. When a big blanket is spread on the floor we find invariably some wrinkles in the blanket. The wrinkles can be easily moved by hand from one end to the other and in this process the blanket suffers a small displacement relative to the floor. If there are no wrinkles in the blanket it requires a very large force to displace the blanket relative to the floor. A similar situation can be thought of as existing in crystals. The wrinkles in the blanket correspond to defects or dislocations in crystals. Just as the wrinkles move easily through the blanket, so also the dislocations move more easily through the crystal. Though the crystals may not initially contain enough dislocations to permit the large plastic strains observed, Frank and Read have given a mechanism of dislocation multiplication which is found satisfactory The crucial factor in the role played by dislocations in plastic deformation is the relatively small stress needed to cause dislocation motion and dislocation multiplication.

The fracture phenomenon also has been explained on the basis of propagation of what are called microscopic cracks. There are many reasons for crack formation in crystals such as surface roughness, surface scratches, etc. These cracks are regions of high stress concentration in a surface. If the stress exceeds the bonding stress, the crack can spread very fast leading to unexpected failures. Fatigue and creep failures also get a satisfactory explanation on the basis of defect structure of crystals. An important point we notice at this stage is, that properties like yield strength, shear strength are highly structure sensitive and this may give scope for the molecular architect to vary the properties by varying the structures.

Why should crystals have defects?

Having established that defect structure is the cause of crystal weakness, we are inclined to ask why crystals should have defects. Again, it is the law of nature that makes it difficult for us to have perfect crystals. Thermodynamics tells us that any system takes up that configuration for which the free energy given by the expression $F=E-TS$ is a minimum. E is the internal energy, T is the temperature and S is the entropy. Creation of defects or dislocations increases the internal energy of the system. But at the same time it also increases the disorder or the entropy of the system. Since the entropy increases faster than the increase of internal energy, a system of minimum free energy necessarily has to be a defective system. In fact, it can be shown that the number of defects per unit volume at any temperature T is given by the expression $n=n_0 \exp(E_g/kT)$, where E_g is the energy required to create one defect On this basis it is calculated that there must be about 10^6 defects per unit volume at room temperature in a metal and this defect density increases enormously with rise of temperature. That is also the reason why the materials yield at much smaller stresses at higher temperatures.

Strengthening mechanisms

The ultimate aim of the microscopic analysis of the mechanical properties of solids is to understand the mechanism of hardening and strengthening the solids which are sick with the inevitable dislocations. The following are some of the methods adopted for strengthening solids: (1) Preparing defect-free materials, (2) Decreasing the grain size, (3) Increasing the dislocations by strain hardening, (4) Pinning the dislocation motion by adding solute atoms (5), Precipitation hardening, (6) Dispersion hardening, and (7) Making composites.

Defect-free materials. Since most of the engineering materials we use are polycrystalline, it is very difficult to prepare defect-free bulk materials. Besides they will be highly unstable thermodynamically. Materials in the form of thin fibers or whiskers, devoid of defects and having very high tensile strengths, can be prepared but they are not quite suitable because they are very brittle. But these fibers have been found to be very good in making composites as we will see later.

Decreasing grain size. Grain size has a marked influence on yield stress, fracture stress and ductility. In a fine-grained material there are more boundaries and its strain-hardening rate is also higher. The boundaries and the dislocations produced by strain-hardening act as barriers for further dislocation motion, thereby making the material stronger. With respect to fracture the grain size diameter can be taken as the initial crack length, and according to Griffith's theory, the fracture stress could be expected to depend on the inverse square root of the grain size. The difficulty in preparing grain sizes less than 10 microns sets a limit for indefinite strengthening by this process.

Work hardening. When you take a fresh copper sheet and bend it, you find it easy in the first instance. When you try to unbend it, you find it has become stiffer. When the process is repeated, the material becomes stiffer and stiffer. When you bend the material or deform the material, you are introducing dislocations. The dislocation density increases greatly during the process of deformation. Later, the dislocation become tangled together in such a disordered fashion that further dislocation motion becomes difficult. This phenomenon is called work-hardening or strain-hardening and is one of the methods used for hardening a material. This process however has the disadvantage of making the material susceptible to cracking or tearing. By special heat treatment like annealing and recrystallisation the material can be strengthened to some extent.

Pinning of dislocations by solute atoms. Another way of increasing the hardness and yield strength of a metal is by dissolving a second metal in it to form a solid solution. If the atoms of the solute metal are bigger or smaller than those of the original material, they will set up local strains around them. These strain fields act as obstacles to dislocation motion and hence raise the strength of the material. The most important example of a solute-hardened material is martensite, the hard constituent of quench-hardened carbon steel. The carbon is first taken into solid solution, upto four per cent in a typical steel, by heating to around 900°C where it is austentitic. It is then held in solution by quenching to room temperature. The steel transforms to the bcc structure under this treatment, but due to the rapidity of the quenching, the carbon is forced to remain in supersaturated interstitial solution and distorts the bcc structure to a body centered tetragonal which is a martensite. The stress field produced by the oversized carbon atom is so intense that the dislocation motion is very effectively hindered.

Precipitation hardening. If resistance to dislocation motion were all that was required of a strong material, we could use intrinsically hard solids like silicon carbide for engineering applications. Such materials are, however, brittle, and it is more often a combination of ductility and strength that is required. The ductility not only makes it possible to work the material to a required shape but also gives a much greater fracture strength (as opposed to yield strength) than does a brittle material. The best combination can be obtained from an intrinsically soft metal that is strengthened by finely dispersed particles of hard substances. Since these particles are usually produced by precipitation, such materials are said to be precipitation hardened. This is the process followed in hardening steel, where particles of iron carbide are precipitated into iron. Aluminium is strengthened by precipitating copper in it.

Each of the above mechanisms we have described can raise the yield strength to the order of G/100 to G/50. Unfortunately, all the mechanisms begin to break down at temperatures where diffusion can occur at an appreciable rate. Precipitated particles begin to dissolve and solute clouds begin, by diffusion, to drift along with dislocations which can climb over the barriers and glide along. The search for alloys with reduced diffusion rates at high temperatures resulted in the development of dispersion hardened materials.

Dispersion hardening. The principle of hardening by creating a closely spaced dispersion of a second phase is of great technological importance. These materials are composed of a metal matrix in which are embedded fine particles of oxides, nitrides, or carbides which are insoluble and incoherent with the matrix. The spacing and particle size are very critical. Since the particles are insoluble in the matrix, transport by diffusion through the matrix is negligible and so they will not agglomerate on heating. This means that unlike precipitation hardened alloys, such materials will retain the strength at elevated temperatures and so may be useful as creep-resistant materials. A typical material is TD nickel where nickel is hardened by a dispersion of thorium oxide. Another material is SAP, an aluminium-aluminium oxide composite.

Fiber composites. This is the latest concept in material strengthening. The basic idea is to achieve the extraordinary strength of thin fibers or whiskers in bulk materials by reinforcing a ductile matrix with the fibers. Glass reinforced plastics is a typical composite. Glass fibers have very high tensile strength but low shear strength. Plastics have high shear strength but low tensile strength. The purpose of the plastic matrix is two fold. It separates the individual fibers so that cracks cannot easily run from one fiber to another. Again, it binds the fiber surfaces so that the stress applied to the composite is mostly transferred to the fibers. For a given load, the strain in the matrix as well as the fiber is the same. This means that the major stress is carried by the fibers. The strength of the composite, σc, in terms of the strengths of the individual components is given by:

$$\sigma c = \sigma_f V_f + \sigma_m (1 - V_f)$$

where σ_f and σ_m are the strengths of the filament and the matrix and V_f is the volume fraction of the filament. If σ_m is sufficiently small and V_f very nearly unity,

$$\sigma c \approx \sigma_f$$

That is, the strength of the composite approaches the strength of the fiber itself. The practical realisation of the strength given by the above equation depends on the availability of the proper matrix and the fibers. The length and the volume fraction of the fibers are critical. If the matrix does not fail before the fiber strength is reached, it is practically possible to fabricate a composite nearing the ideal strength. A composite consisting of silicon carbide fibers embedded in a suitable epoxy resin gives a strength of 10^5 kg/cm^2 and this compares very favourably with the strength of the strongest available steel whose strength is $.42 \times 10^5$ kg/cm^2. Fiber composites seem to be the materials for the morrow and much work is being done at present to use this new philosophy to obtain strong materials.

Work done in India

The idea of fiber composites was first introduced in 1940. Since then the progress has been very rapid and tremendous. The fabrication of defect-free fibers requires some sophisticated technology which was not available in India till 1965. Till then glass fibers and resins were imported in our country. In 1965, a Bombay firm started producing glass fibers in India. Today almost all the essential raw materials for this fiber composite industry are indigeneously available. Research work on fiber composites is extensively being done at the National Aeronautical Laboratory, Bangalore and the Indian Institute of Technology, Madras. The results are quite encouraging and the technologists of tomorrow can hope to get materials with any required properties ranging from soft rubber-like materials right up to materials stiffer than steel, with ability to withstand very low temperatures to very high temperatures and survive very many mechanical abuses. Development of strong materials will make our nation definitely strong in all respects.

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Cities under the sea

POPULATION explosion forces us to view the earth's land masses in a new light. Experts say that the world's population will double by the year 2000. If this is true we should start exploiting the resources of the sea immediately. Population explosion has created two incompatible requirements. The first for more room to live in and the second for more food to eat. If the amount of arable land is reduced to provide living room, where will we find the land to grow the food for the larger population? We would not find the answer to these questions in outer space, because it is doubtful how many people will be living out there by 2000 A.D. The oceans can provide these answers if we exploit their potential intelligently and systematically.

Until recently this fascinating world of 'inner space' had been all but forgotten by human beings who inhabit only 28% of our planet located above the ocean's surface. There is no doubt that this barrier, the ocean's surface, has been one of the most formidable obstacles that man has known. Oceanography, the science of the oceans, is less than 100 years old though we have used these waters for commerce and limited food production for many hundreds of years. It is just in the last few years that we have moved into this area with an increasing sense of urgency, both from military and economic points of view.

There are dramatic legends about Alexander the Great's underwater observations from a glass barrel some 2300 years ago. Herodotus and Pliny spoke about marine science a century earlier. Leonardo da Vinci, the multi-faceted renaissance genius, designed an underwater apparatus. In 1609, Buonaiuto Lorini, a Venitian, also designed a diving apparatus. In the develop-

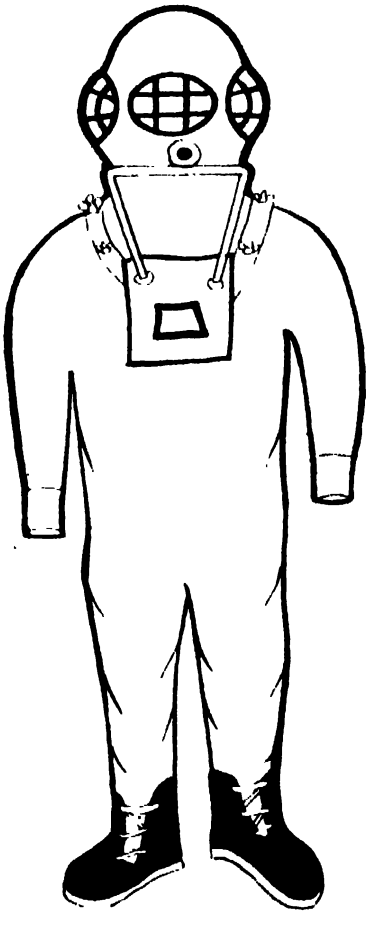

Fig. 1. August Siebe's first 'closed' diving suit of 1837

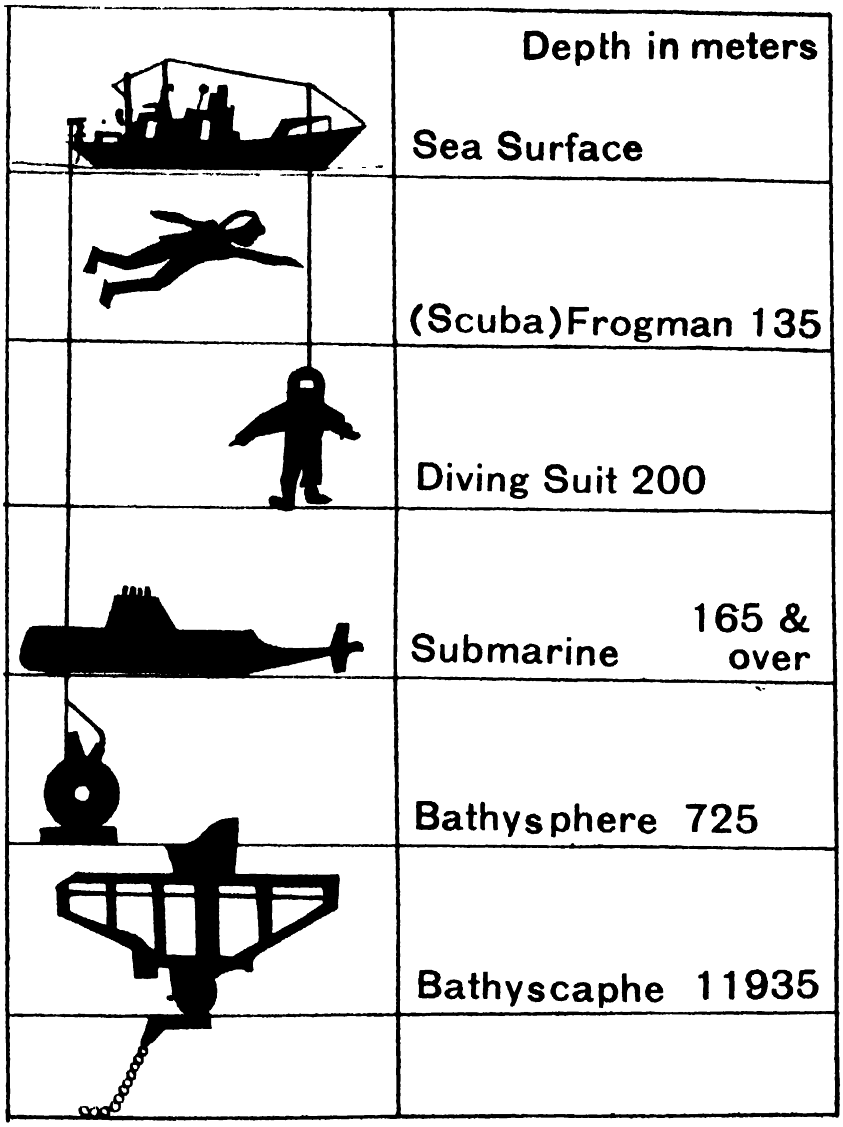

Fig. 2. Maximum depths at which various kinds of diving apparatus have been used

ment of underwater vehicles and diving, the names of John Williams (1692), John Lethbridge (1715), Abbe de la Chapelle (1775), Klingert (1797), Count Piatti del Pozzo (1898) and William Beebe (1930) are noteworthy. In the 20th century development of free diving techniques, the major contributions were by French people. Among them Commander Jacques-Yves Cousteau outshines the rest. A historic meeting between Cousteau and engineer Emile Gagnan in Paris in 1942 led to the most spectacular invention for opening up the oceans for free-swimming people—the aqualung. Since then there were two recent historic occasions which marked the birth of modern oceanology. One was the submerged crossing of the North Pole by the U.S. nuclear submarine *Nautilus* on 3rd August 1958 and the second was the descent to the bottom of Challenger Deep in the Marianas trench by Jacques Piccard and Don Walsh in the bathyscaph *Trieste* on 23rd January 1960. In 1965, Jacques Coustaeu again made history by his first *Conshelf* experiment. His team of divers lived underwater for one week at a depth of 30 feet, working from a cylindrical habitat moored on the sea floor and supplied with compressed air from the surface. This was followed by another more ambitious experiment. Many other experiments have since been carried out on the possibilities of living and working under the sea. Among them perhaps the best known are the American *Tektite* and *Sealab* programmes.

Many scientists are investigating the physiological problems concerned with submarine operations to assess human ability for enduring the long hours away from normal daylight and in close confinement. So far, the results have been very encouraging, but it must be remembered that the men they are working with are specially selected and tested for the rigours of submarine duty. In other words, they have been found to have the best adjusted personalities for adapting themselves to the job. The question then is not with a special selected group but with the average family and how they will be able to live away from the normal stimuli that make up a large part of our everyday life. "Stimuli" means the daily cycle of the sun passing across the sky, the stars, the moon, the smells, the noises, the rain, and the wind. It is very difficult to think about life without these things. So it is certain that there would be an artificial environment in the underwater city of the future but it would take some time to get used to it before it could become second nature to the inhabitants.

Man's first line of exploitation of the sea will be in harvesting its animals, mineral and vegetable resources on an efficient large scale basis. People will be ready for life in underwater cities when our coastal metropolitan centres become so overcrowded and people begin to strangle due to population congestion. At first these underwater cities will be in the form of residential areas near to the coastal cities. They would be located in fairly shallow water, not more than about 140 metres deep, on a flat or gently sloping bottom. At this depth there would still be quite a bit of sunlight though it would be blue tinted due to water. These underwater communities would be under a series of plastic domes connected by communication tubes for roads, walkways, and utilities. The gentle blue light would give the plastic 'sky' a late afternoon glow during the daylight hours on the surface. During dives with the *Trieste* there was daylight down to about 260 metres and twilight down to about 460 metres even though the weather on the surface was cloudy.

The artificial atmosphere would be created and controlled by a nuclear power source. The purity, humidity and the temperature of the air would be closely controlled to provide the most healthy environment for the residents. There would be no more smog, hayfever and the uncontrolled atmosphere of the surface. Heating of the air would be unnecessary due to moderate temperature of the surrounding sea water; however, this would depend somewhat on the location of the community.

Transportation to and from the sea floor would be via a rapid transit system that would either terminate at the city end of the entrance tube or connect directly into the city's rapid transit system. An electric monorail system would be ideal for this application. Any sort of internal combustion engine vehicles would not be allowed in the underwater community, as their products of combustion would create an overwhelming burden on the atmospheric conditioning system. The rapid monorail system would carry people to within a short walking distance from their homes. Many people would have little electric carts for running local errands as would the service people such as the milkman and the grocery boy.

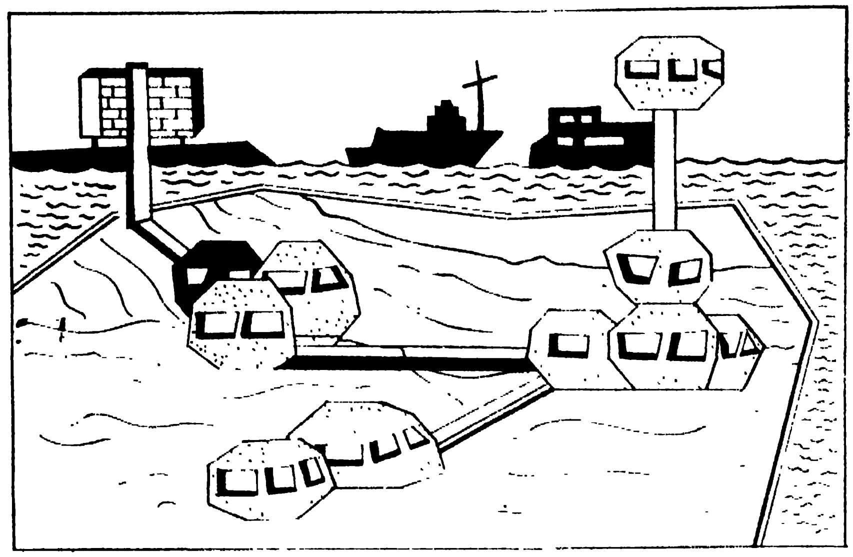

Fig. 3. Artist's concept of a future city under the sea

The home itself would be quite conventional-looking with a few exceptions. It would be connected to a central ventilating system much as the homes are now connected to sewers and water mains on land. This system would provide a constant ventilation of the home and would also be connected to the stove, water heater and fireplace to exhaust the fumes from these devices. These fumes and gases would be carried off through underground exhaust mains to the exhaust tunnel where they would be sent up to the surface of the ocean. Of course, the extensive use of electrical power for all uses would be encouraged to avoid any possible contamination of the underwater community's atmosphere. It would probably be cheaper too as the nuclear power plant would be capable of making electricity cheaper than any other devices. Lighting in the home would be more important than it is now. With proper design one would be able to regulate the daily lighting to duplicate the passage of the sun across the sky. For this reason windows will not be as important as they are in the terrestrial home. Radio and television programmes will be brought in by underground wires similar to telephone wires.

Outside the home it could be noticed that there will not be any telephone or electric poles as all utilities will be underground. Nor will there be the forest of TV antennas that punctuate the skyline of the surface suburban communities of the advanced countries at present.

The gardens of the underwater cities will be a little different. The landscape architect will have to find plants that will be able to thrive in the artificial environmental conditions. It can be done although some of the favorite plants will not adapt to life away from the direct rays of the sun. Every home will have a built-in sprinkling system that will have two functions. The first will be to provide the rain that mother nature cannot give to the underwater gardens and the second will be to give every home a built-in fire fighting system much as in the large commercial buildings on the land surface.

City blocks would not exist, instead the plastic dome would be the unit of division. Each one could be quickly isolated in case of fire or flooding just as in the naval ships. The hemispherical domes would be double walled or concentric so that a break in the inner or outer wall would not cause flooding of that particular dome. The sub-oceanic fire department would have to be very efficient at not only in stopping fires but also in the techniques of damage control in case of flooding. The underwater cities would be a lot safer than those on the land.

Perhaps all these may be a little too futuristic. But we should remember the proverb—necessity is the mother of invention—and the force of necessity is a strange thing. After all, the idea of living underwater by the end of this century is not so unusual. Already many of the new office buildings on land are being built without windows to get in the light of day. Think of the workers who live in cubicle-like apartments and go to work on the underground subway to their window-less office buildings. Have they not adapted themselves to an unusual environment?

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Large earthquakes wobble the earth

THE dictionary meaning of the word 'wobble' is 'to move unsteadily from side to side'. This word is often used in expressing the gait of a heavily drunk or ill person. Our mother earth, it would be a surprise for many to learn, also, 'walks' in this manner in her long repetitive journey round the sun! What causes her to act so is still a debatable issue. This is partly due to the fact that the 'wobbling' of earth is a complex phenomenon and partly because scant observations of it are available in the records of the past centuries.

Called specifically as Chandler Wobble, in honour of its discoverer, its origin is attributed to varied phenomena happening on and inside the earth; for instance, due to atmosphere, oceans, earthquakes, internal core-mantle interactions. Neither any of them is considered as the principal contributor to the wobbling, nor ruled out as a partial one. In short, the Chandler Wobble is today one of the unsolved problems in geophysics and the present researches are trying to solve it.

A recent effort in this direction was made by Richard J. O'Connell, of Harvard University, Massachusetts, and Adam M. Dziewonski, M.I.T., Massachusetts (*Nature*, **262**, 22 July 76). According to them, the large earthquakes have almost a fifty per cent contribution to the present wobbling of the earth. What makes their evidence convincing, its pros and cons, and how it tries to solve the problem would be better understood if the wobbling of the earth is discussed.

It is a well-known fact that the earth is spinning about its axis once every day. Consider that it has a 'leg' on which it can stand, just as a top does. Assuming the earth to be a perfect sphere with mass equally distributed, it would spin in a 'stable' manner as shown in Fig. 1(a). But this is an ideal case. The earth, apart from being oblate, has discontinuities present on its surface such as mountains, shelfs, plains and internal irregular mass distribution. It being unsymmetrical, its axis of spinning changes and so it not only spins but also revolves; the process is called precession. It behaves just as a spinning top having one side of it more heavy (Fig. 1b).

Such a precession of the earth's axis, on the surface of the earth called the wandering of poles (as the poles of spinning axis rotate about the geographical poles of the earth) [Fig. 1.(c)], was calculated in 1765 by Eular, the great mathematician. Called as Eular's nutation, he calculated the period of polar motion of the earth as about ten months. However in 1859 Chandler in actuality observed it using the 'variation of earth's latitude' technique; its period was found to be much more, about 14 months. Morever the fluctuations in the period are of the order of four per cent, which could not be attributed to some natural cycle occurring in and about the earth. Also, as could be imagined, the motion traced out by pole, say, north, about the north geographical pole has to be a circle (Fig. 1 e), which, observationally, it is not. The trace of the polar motion

"Our town falls on seismographic line. Please, Sir, don't make an earth-shaking speech."

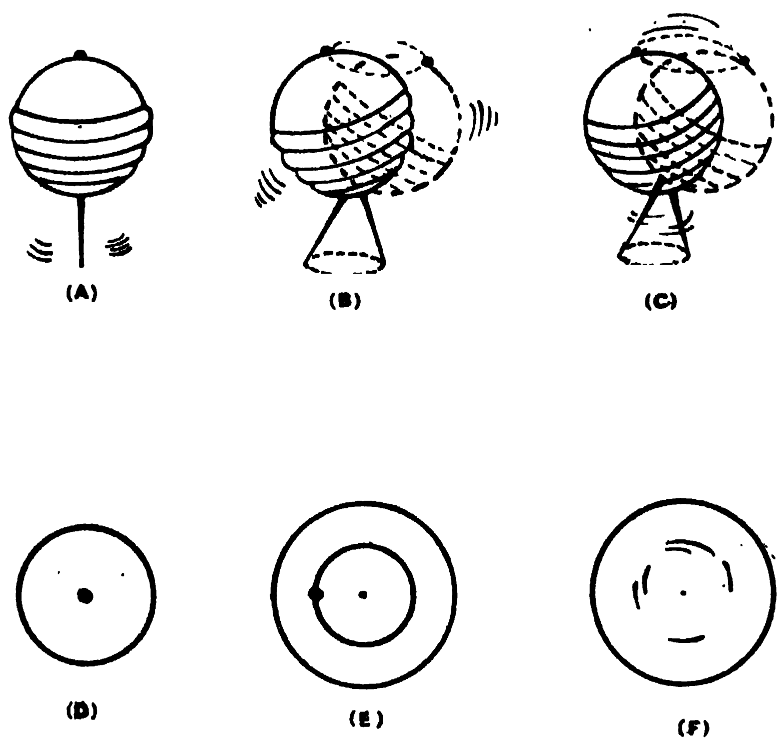

Fig. 1

is as shown in Fig. 1(f), comprising of many arcs with different centres. Apparently, the poles are being randomly jerked – literally. This is a clear indication of the fact that many other irregular or may be regularly irregular forces also influence the wobble and so it is not as simple as it was first imagined.

The causes for the jerks, now detected, are both inside and outside the earth. The earth, it is now firmly believed, contains lot of liquid and is enveloped in atmosphere, both acting as viscous fluids. When any phenomenon excites the spinning earth, it, having got excited (to say simply, disturbed), changes the period of wobble; but what results due to its liquid inside and air outside, is of more complex nature. Like the pendulum, which when once excited to oscillate gradually slows down due to the viscous damping of the air around, the earth too, after excitation, is damped—and that makes its wobbling more complicated and puzzling.

The recent study on the cause of wobbling by Richard J. O'Connell and Adam M. Dziewonski was based on 234 large earthquakes that occurred in the period 1901 to 1970. The amplitude of the earth's wobble changed in this period was very large in 1910; fairly uniformly decreased from 1910 to 1920; then till 1940 remained small but nearly constant; increased thereafter to reach a maximum in 1954; and since then is declining irregularly. What O'Connell and Dziewonski did was to calculate the synthetic Chandler wobble over the 70 year period based on the current earth models and data of the timings, location and strengths of large earthquakes which occurred during the period. A comparison between this synthetic wobble and the actual wobble observed in the period indicated that though they do not tally exactly, they "exhibit a similar order of complexity". This is quite a convincing agreement, as it has been observed that the effect of large earthquakes on wobbling is unpredictable; it can decrease or increase the amplitude of wobble.

The concept that earthquakes must be affecting the wobble is certainly not a novel one. Much earlier when it was first proposed it was ruled out on the ground that a single earthquake cannot affect, or contribute to, the wobble. Interest in this concept was, however, triggered off by the work of D. E. Smylia and L. Mansinha, who found evidence suggestive of a correlation between the earthquakes and the wobble period. The strongest objection to this concept was the observation that on occasions it was observed that the wobble-amplitude of the earth changed before an earthquake took place. An example of this is the earthquake at Chile in 1960, in which a few minutes before its occurrence the wobble amplitude changed. O'Connell and Dziewonski have found a solution to this puzzle.

'Silent earthquakes', also called aseismic events, they claim, are happening inside the earth, of which only recently geophysicists are becoming aware. These aseismic events, it is claimed, are more frequent than previously believed. They, however, bring about similar effects —all internally, what an otherwise normal earthquake produces externally as well. Substantial evidence of such silent earthquakes has not appeared in the literature but two researchers, J. N. Brune and G. F. Davies, have on their basis calculated accurate plate tectonic displacement rates which arise at converging boundary plates.

To conclude, O'Connell and Dziewonski claim that the Chandler wobble is caused partly by the cumulative effect of large earthquakes and partly by the earth's atmosphere; other minor variations may arise from oceans, moon's destabilising gravity torque, core-mantle interactions, etc.

Why one needs to know about the Chandler wobble? As mentioned above, that once the wobble is excited by a disturbance on or inside the earth, the earth is damped internally. So by studying the wobble, much about the earth's innards could be understood, which, in turn, would help us to comprehend many unpredictable and disastrous geophysical phenomena like earthquakes and volcanic. erruptions. Even the inadequat eresearch in this field indicates that the earth contains much more liquid than believed till now. Indeed, the earth wobbles because it is drunk to the full.

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Petroleum waxes

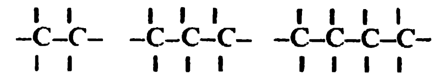
THE great industrial development of the present day depends on the ever-increasing extent of the application of scientific knowledge and the scientific methods of control over the operations of manufacturing processes. New industries often owe their existence entirely to the result of scientific researches which, in many cases, at the time they were carried out, gave no indication of their future great commercial value. The researches which are of great scientific importance and interest may not have any obvious bearing on the problems of manufacture and applications.

Wax is an important petroleum product manufactured in the country and marketed both at home and abroad. It occurs in most crude oils in dissolved state and hence its presence is not obvious at ordinary temperatures, but as the temperature falls during refining of oil, the wax begins to separate out. This temperature is largely governed by wax contents in crude oil; the greater the amount of wax, the higher is this temperature. After separation from oil, wax constitutes a valuable and interesting product in its own right, with special qualifications for a number of important uses, e.g., boot polishes, cosmetics, electrical insulators, water-proofings, candles, matches, gramophone records, carbon paper, etc. It is manufactured in a large number of grades. For marketing purposes, grades stand for melting points or actually setting points and do not refer to the quality of wax. Waxes having melting points ranging from 37°C to 93°C are commercially available.

Waxes melting above 49°C may be made practically free from oil and are semi-transparent, colourless and odourless. At ordinary temperature waxes of these grades are hard and frequently brittle, but on warming they become progressively softer and more plastic, finally melting into a thin clear liquid. The presence of small quantity of oil, due to insufficient refining, greatly affects certain properties. Such wax easily discolours when exposed to light and, with as little as 5% oil, is much reduced in mechanical strength, becoming easily crushable to a fine powder. The lower melting grades, 37°C to 49°C, usually contain oil and are more or less yellow. Wax of this kind is soft and plastic at ordinary temperatures.

Chemistry of petroleum waxes

All materials found in nature are formed due to combination of atoms of various chemical elements and, in the case of waxes, the predominating elements are carbon and hydrogen. An atom of an element may combine with other atoms of the same element, and in particular, hydrocarbons consist of crruptions different numbers of C-atoms uniting together, with hydrogen occupying the remaining valencies:



$$\begin{array}{cc} | & | \\ -C- & C- \\ | & | \end{array} \qquad \begin{array}{ccc} | & | & | \\ -C- & C- & C- \\ | & | & | \end{array} \qquad \begin{array}{cccc} | & | & | & | \\ -C- & C- & C- & C- \\ | & | & | & | \end{array}$$

ethane propane butane

This type of compound is known as a saturated compound as there is no possibility of further combination of the molecule with anything else. At each end of the chain will be a —CH_3 group and in between them the remaining groups will be, of course,—CH_2 groups, e.g.

CH_3-CH_2-CH_3 CH_3-CH_2-CH_2-CH_3
propane butane

The whole series of such hydrocarbons is known as the paraffin series or alkane series having the general formula, C_nH_{2n+2}, where n=1, 2,... etc.

Waxes are essentially mixtures of hydrocarbons which are all members of only one family—the paraffin series. The simplest member of this series is a gas, methane (CH_4), but the more complicated ones are successively liquids and then solids as the number of carbon and hydrogen atoms per molecule increases progressively. Paraffin waxes are high molecular weight members of this series.

Petroleum wax is principally a mixture of solid paraffins, the number and nature of which have a considerable effect on the properties of the mixture. For a given composition, a number of different paraffin hydrocarbons exist, dependting on the manner in which the component atoms of carbon and hydrogen are linked together. These fall into two broad classes—normal, and iso-paraffin. In the first, the C-atoms are joined together in one continuous chain and in the second type some C-atoms are attached branch-wise to others in the main chain. Different hydrocarbons having the same number of C and H-atoms but capable of being represented as straight chain or branched chain compounds are called isomers. As the number of atoms in the molecule increases, so does the number of possible isomers of the compounds.

Various kinds of waxes are obtainable from crude oil differing markedly in their physical properties and commercial applications, but it is believed that the relative amount of normal and iso-paraffin hydrocarbons is an important factor contributing to the differences in properties. On this basis, two main types of petroleum waxes are commonly recognized.

Paraffin waxes

When crude oil containing wax is distilled, a good deal of wax distills over. The lube-oil fractions and the wax distillate so obtained is chilled to a lower temperature, viz., 30°C. It is then allowed to filter through a large filter press. Filter cakes so obtained constitute crude waxes but they still contain 10%-40% oil which has to be removed. The crude wax is melted and allowed to settle by floating on the surface of hot water. The rate at which the wax cools is of importance, as the slower the cooling, the better the development of crystalline structure and the more easily can the oil flow away from interstices between the crystals in the sweating process. Thereafter, the slack wax is stored in the form of slabs in a room, the temperature of which can be slowly raised, at the rate of 1° C per hour. The sweated wax is still not quite colourless and is therefore subjected to refining process. This consists of treatment with sulphuric acid followed by Fuller's earth (aluminium silicate clay) in mechanical agitators. The melted wax is then cast into blocks and it is ready for sale as paraffin wax.

This wax consists of large visible crystals which make it inapplicable for most uses of wax, although well-developed crystals facilitate pressing and sweating. The crystal size may greatly be reduced by mixing with other substances. Melting point range for this wax is 32°C to 65°C. Molecular weight and oil content are 225 to 440 and 1% respectively.

Micro-crystalline waxes

They are found along with lube-oil fractions from which they can be separated by dissolving the wax-bearing oil in a suitable solvent, e.g., dichloroethylene, propane, etc., and refrigerating the mixture to a lower temperature at which the solvent power of oil which is itself an excellent solvent for wax falls off quickly and wax separates out as clouds of small crystals. Now, separation is done either by filtration or centrifuge in an instrument just like the cream separator in which oil solution behaves as milk and wax as a cream. After separation the solvent has to be removed by distillation. Micro-crystalline waxes may contain additives such as polybutenes which partly inhibit crystalline growth and tend to increase plasticity.

They are less volatile, usually made up of much smaller crystals and are considered to contain a large number of iso rather than n-paraffins. They are generally more opaque than paraffin and may vary from soft and plastic to hard and brittle and from white to dark brown in colour. They have m.p. range and molecular weight 65°C to 98°C and 450 gm to 1000 gm respectively. They usually have appreciable quantity of oil, sometimes upto 15%. It should be noted here that the highest m.p. waxes of this class could be made only from tank bottom.

Finally all types of waxes are melted and then cast into blocks when they are cold, and when completely solidified they are packed for transport.

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Cyclic adenosine 3':5' monophosphate and brain function

THE discovery of cyclic adenosine 3' : 5' monophosphate widely known as cyclic AMP (c-AMP) and an appreciation of its biological significance grew out of the classical work of E. W. Sutherland and his collaborators (1951-1957) on the hormonal stimulation of glycogenolysis. Soon after this discovery, neuroscientists, in the last few years, have turned their serious attention to this elusive molecule which may provide an important key for explaining many of the unsolved phenomena in brain regulation. A. L. Goldberg and coworkers (1959) investigated the possibility that c-AMP is involved in the release of neurotransmitters, because of the fact that : (i) the enzyme adenylcyclase (catalyses the formation of c-AMP from ATP) and phosphodiesterase (catalyses the hydrolysis of c-AMP to 5'-AMP) are found in high concentration in brain and on differential centrifugation they are primarily present in that fraction containing synaptic membrane; (ii) evidences suggest that the release of neurotransmitters and the release of intracellular packets from exocrine and endocrine tissue may occur through similar mechanism; (iii) much of our knowledge of synaptic mechanism has been obtained through studies of transmission at the neuromuscular function. It is well established that catecholamines facilitate neuromuscular transmission by promoting the release of acetylcholine from motor neuron.

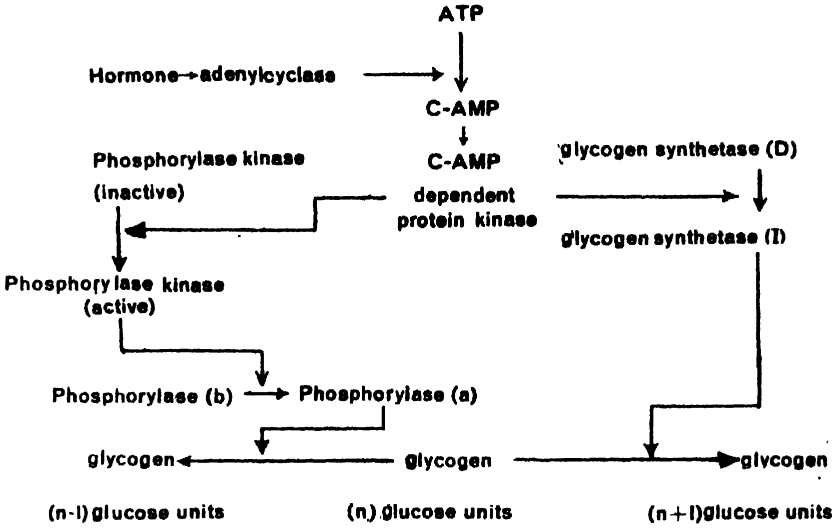

Fig. 1

Role of c-AMP in metabolism

Of recent interest the following metabolic roles of c-AMP are fairly known.

(i) Histone phosphorylation and neuronal function,(ii) Glycogen metabolism, and (iii) Pineal gland function. Much evidence has accumulated to support the idea that the formation of long-term memory requires the synthesis of RNA and protein (E. Glassman, 1969). The general scheme for regulation of RNA and protein synthesis may operate in brain also, with the hormone replaced by a neurotransmitter. In neurons, c-AMP generated by neurotransmitters might induce specific synthesis of proteins needed to form more efficient synaptic connection. According to this view, some of c-AMP generated by the neurotransmitter would find its way to the nucleus, resulting in the phosphorylation of histone and the synthesis of specific RNA and protein, while the more immediate effects of the transmitter, such as impulse generation and the changes upon which short-term memory depends would be mediated by interactions of c-AMP or neurotransmitter with some pre-existing component of the synaptic structure. In this way, the use of a synapse would result in the synthesis of proteins required for permanent facilitation of transmission across that synapse. c-AMP plays a dual role in glycogen metabolism and possibilly all biochemical effects of c-AMP are mediated via protein kinase activity (Fig .1)

Glycogen is hydrolysed to G-I-P by the enzyme phosphorylase, which exists in two forms b and a. Phosphorylase b is converted into phosphorylase a by an enzyme phosphorylase kinase, which exists in two forms, active and inactive. A c-AMP dependent protein kinase has been shown to activate phosphorylase kinase. In contrast to glycogen breakdown, glycogen synthesis is dependent on an enzyme glycogen synthetase, which also exists in two forms inactive (D) and active (I). The same c-AMP dependent protein kinase catalyses phosphorylation of glycogen synthetase to an inactive form. Glycogen synthesis is shut off as soon as glycogen breakdown is commenced. On the other hand glycogen breakdown ceases when c-AMP concentration decreases with an accompanying dephosphorylation of phosphorylase and synthetase I by an enzyme phosphatase, which also requires c-AMP for its activity.

Recent studies of potential role of c-AMP in pineal function have been well described. The addition of Norepinephrine (NE) to rat pineal organs cultured with C^{14}-tryptophan resulted in increased levels of C^{14}-tryptophan, and C^{14}-protein within the gland as well as increased secretion of C^{14}-hydroxy tryptamine, C^{14}-melatonin, and C^{14}-hydroxy indole acetic acid (HIAA) into the medium. Dibutyrl c-AMP (DBC) enhanced the effects of NE on the release of radioactive indoles into the medium, but it did not enhance the uptake or incorporation of C^{14}-tryptophan into protein. Alpha-adrenergic blocking agents, such as dibenzylene, had no effect on either action of NE. However, the effects of NE, but not the DBC on pineal indole synthesis is blocked by beta-adrenergic blocking agents, such as propanolol NE apparently acts on two receptors in the plasma membrane of the pineal parenchymal cell; (i) it stimulates tryptophan transport into the cell, (ii) it enhances the activity of adenylcylase and thereby stimulates the synthesis of c-AMP. This c-AMP acts at one or more undefined intracellular loci to acclerate the formation of serotonin and melatonin. Thus the factors which control melatonin synthesis are important for the pigmentation of skin, pituitary gonadal function, sexualy maturation, ovarian growth and cyclicity.

c-AMP and current developments

Of current interest in the c-AMP research in brain regulation, mention may be made of two important developments, viz., (i) whether specific hormone receptors and the enzyme adenylcylase are components of a single molecule as suggested in an earlier hypothesis by G.A Robison (1967, 1969) that hormone receptors are part of a "regulatory sub-unit" of adenylcylase; and (ii) involvement of c-AMP with behavioral disorders related to manic and affective illnesses.

Outstanding work of different group of investigators [G.A. Robison, E.W. Sutherland and other, (1970); O.M. Rosen and S.M. Rosen (1970); B. Weiss and co-workers (1970)] gives a suggestive evidence that receptors and adenylcylase are not necessarily a part of the same molecule.

c-AMP has been implicated as a possible mediator of behavioral changes. Semi-micro injection of dibutyryl c-AMP (DBC) into various areas of brain produce different behavioral changes. Thus injection of DBC into lateral ventricles of cat brain produces a syndrome of agitation and hyperexcitability. When injected into mesencephalic reticular formation it produces catatonic-like state. Unlike c-AMP, DBC when injected is not destroyed by phosphodiesterase which is abundant in all regions of the brain except cerebellum, where c-AMP produces some effect as DBC. The effect of DBC cannot be blocked by pre-injecting animals with reserpine (which blocks NE stores in nerve cells) or chlorpromazine (which blocks adrenergic receptor sites) indicating that the effects are not adrenergically mediated. Measurements of endogenous level of tissue c-AMP showed interesting results. Abdulla and Hamada (1970) confirmed the finding that urinary excretion of c-AMP in mania is elevated while in depression the level is markedly diminished. Patients treated with L-dopa showed dose-related increase in c-AMP excretion in association with clinical change. It has been claimed that imipramine, amitryptyline, and nortryptyline might improve the level of c-AMP by inhibiting brain phosphodiesterase activity. It has been pointed out that changes in urinary c-AMP are associated with the 'Switch process' from depression to an agitated manic state. This specific psychobiological process in accompanied by a rapid and profound change in mood, behaviour, thought content which probably reflects sudden marked alterations in brain metabolism.

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Food cooking by microwaves

We are constantly exposed to the electromagnetic radiation coming from various sources like broadcasting and radar. Since World War II, researchers have been attempting to find out the ill-effects of electromagnetic radiation on human health.

Since 1946 the microwave heating is being successfully used in diathermy, a technique used for providing therapeutic heating to tissues by the conversion of physical forms of energy like ultrasound, electromagnetic shortwaves, or microwaves into heat after being transmitted to deep tissues and fatty layers beneath the skin. The technique has been used in physical medicine from the time physical energy sources have been available to man. Meanwhile, this process of microwave heating appeared in the form of a spohisticated new kitchen appliance, the microwave oven. Now, housewives can utilize this microwave appliance in kitchens. Today, Japan is producing more than 800,000 microwave ovens in a year.

In conventional heating the material to be cooked is kept in a metallic pot and the pot is heated. Heat is transferred to the surface of the material by conduction, convection and/or radiation, and into the interior by thermal conduction. In this process a large amount of heat is wasted in heating the pot.

Moreover it takes long time to cook. On the other hand, in the microwave heating the heat is generated directly inside the material. Therefore, the temperature rises fast to cook the food.

The application of microwave energy for diathermy and cooking is dependent on three variables; radiation intensity, frequency, and the molecular characteristics of the irradiated material. For example, water absorbs incident microwave energy readily converting it into heat.

On an atomic scale, water molecules are actually tiny electric dipoles (an electric dipole is a combination of two equal point charges of opposite signs separated by a small distance) that attempt to align themselves with the rapidly oscillating microwave field. This continuous molecular movement (kinetic energy) produces extensive, increased collisions (friction) between adjacent water molecules and thus heating the entire medium.

Other common substances such as glass, ceramics, chinaware, plastics and paper are transparent to microwave as their molecules are electrically neutral at all points. Microwave ovens are much more efficient than standard ranges because of the "molecular discrimination". Energy is spent only in heating the food which typically has a high water content, while containers, cookware and even the oven's reflective metal walls remain cool.

Microwave oven

The microwave oven is simply a chamber connected through a waveguide to a high power microwave generator, the magnetron. A glass plate is fixed on which the food to be cooked is kept. The microwaves generated by the magnetron at a frequency of 2450 MHz enter the chamber via waveguide system. At the entrance of the chamber the mode stirrer breaks up microwave radiation in such, a way that all parts of the oven cavity, and therefore the food, are evenly irradiated. The internal surfaces of the chamber walls also reflect the microwave energy incident on them, and hence all the microwave energy is absorbed by the food. The magnetron is either 'on' delivering full rated output to the oven cavity or it is 'off'. Essentially all the available microwave energy is absorbed by the food regardless of size. For example, two potatoes will take about twice as long to cook as one potato.

The operating frequency affects the depths of tissue or food penetration at which microwave energy can produce heating. The, majority of microwave ovens now being manufactured and used operate at 2450 MHz. Originally this frequency was assigned to diathermy equipment in 1946 due to its claimed superior therapeutic value.

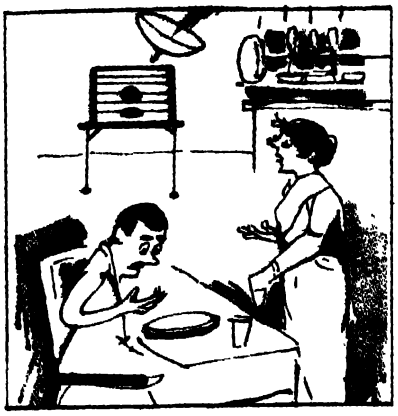
Recently, Dr. A.W. Guy and his colleagues of the University of Washington School of Medicine, USA, criticised the use of microwave fequency of 2450 MHz while discussing the Therapeutic Applications of Electromagnetic Power as "....a classic example of how the historic lack of engineering in medicine has prolongated ill conceived practices, not only in medicine, but also in non-related industrial applications....the frequency be changed to 900 MHz or less" (*Proceedings of IEEE*, Vol. 62, No. 1, pp. 55-75, January 1974). Unfortunately, the lower frequency equipment with sufficient power is not commercially available at present.

Processing requirements

Before selecting the food to be cooked by microwave heating a lot of information about it is needed. All food materials are dielectric (insulator) in nature. A dielectric is a non-conductor of electricity and is a substance in which an electric field gives rise to no net flow of electric charges but only to a displacement of charges. Therefore a parameter known as dielectric constant, which is a measure of insulation, is an important quantity. The dielectric heating, a form of heating in which electrically insulating material, which may be food, is heated by being subjected to an alternating electric field (which may arise from microwaves), which results from energy being lost by the field to electrons within the atoms and molecules of the material. A higher loss of electromagnetic energy within the dielectric material produces higher rise in temperature. If the dielectric constant of the food material is high, it will absorb more incident power and better results will be obtained. But dielectric constant is not the only decisive factor as the dielectric properties of food material are greatly affected by frequency, temperature, composition, and to some extent, by orientation in the field. The electromagnetic waves incident on the surface of the food material are attenuated exponentially. The penetration depth, the distance from the surface where the power of the wave has decreased to 0.37 of the surface value, is an important quantity. The greater the penetration depth the higher will be the energy produced. At a low temperature the penetration depth is high. At higher frequencies the dielectric loss is low but the low electric field results in a high rise of temperature. Hence, the proper compromise of frequency, temperature, design of the oven and the field strengths is needed beforehand. Also, it is necessary to know the dielectric properties of food materials if it is desired to heat mixtures of food materials.

Food processing results

Many promising results of food processing by microwave heating are



"Take it easy, Dear. The food is not fully cooked today because the microwaves were interrupted by clouds while I was cooking"

available. In many cases the technique has been industrialised. It often takes several days to thaw frozen foods in bulk at cold storage temperatures. The usual heating techniques pose dangers of contamination. To solve this problem microwave dielecric heating has some value. For thawing fish, meat, etc., treatment times of less than one minute have been reported at capacities of 1/2 ton/hour with the processing cost below one paisa per kilogram for a 10 kilowatt plant. With such a plant the reduction in processing time by 75% and reduction in weight loss by 5%-10% has been achieved corresponding to a cost saving of about 35 paisa per kilogram. Now microwave heating is used in preparing meat patties and instant rice. This technique is economically advantageous, for it gives fat of better quality than is possible by conventional heating.

Pasteurisation destroys vegetative microorganisms and heat labile-spores. Pasteurisation by microwave heating for 2-3 min. after packaging of sliced bread and cakes to a final temperature of around 65°C -70°C reduces mold infection and increases shelf life. One such industrial plant for microwave bread pasteurisation has been installed in a Swedish bakery. Good experimental results are available for microwave pasteurisation of ham. In laboratories, pasteurisation of milk, beer, and other nonviscous beverages is common. Laboratory scale experiments to kill all pathogenic bacterial spores in food packed in plastic pouches using microwave heating improved the flavour qualtity of foods. The microwave blanching of potatoes and a range of vegetables also improves their flavour. However, the microwave heating for this purpose cannot compete economically with the very efficient conventional heating methods.

The best known and largest commercial application of microwaves is the frying of potato chips. There are more than 20 industries for it in the United States. The reason for its success is that lower quality potatoes can be used which, otherwise, show brown discoloration. The process has improved the storage life of potatoes also. Another development is the microwave dehydration of fruit juices and fats. With microwave heating the moisture level can be reduced to 3% in 25 min. It is interesting that the quality of the fruit juices is markedly improved.

Through microwave dielectric heating baking time for bread has been reduced to minutes. However, for baking, microwave heating is more expensive than conventional baking. But this should be weighed against the reductions of baking time and saving of floor space together with a slightly larger bread volume. Microwave heating has considerable potential for high temperature, short time sterilisation of foods. It provides biological stability with improved quality compared to presently available sterilization methods for solid piece food materials.

As heat is generated directly inside the food material itself, the advantages with dielectric heating alone or in combination with other heating methods are that very fast heating in depth is possible. Microwave heating leads to improved yield and quality. In addition, the process is compact, flexible and well suited for continuous and automated heating lines. Rapid heating through insulating packaging is possible and sometimes advantageous.

Indian perspective

Food cooking by microwave heating in Indian conditions is very uneconomical, for it reduces drastically the manpower needed. The initial installation cost is also very high. Microwave ovens are very costly. The most important factor which keeps the microwave oven away from Indian kitchens is that a lot of data are needed for cooking the mixture of vegetables with salt and 'masalas' in a wide range of combinations.

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All about alfalfa

ALFALFA the world's foremost forage crop is also a homoeopathic tonic. Popularly known as 'Lucerne' the plant was called Haliss by the ancient Greeks. Fifty million acres are under alfalfa all over the world, but in India it is confined to military farms only.

Botanically alfalfa is *Medicago sativa* Linn. It belongs to family *Leguminosae* of pulses like clover, berseem and indigo plants. The shoots are erect and have foliage resembling *methi* and purple flowered racemes. The pods are spirally coiled up bearing kidney-shaped seeds. There are many varieties and taxonomically recognisable entities which go under the name of alfalfa.

Alfalfa plant prefers neutral or slightly alkaline soil. It requires more moisture than barley and wheat. In cultivation, the lucerne fields are flooded once a month and tops harvested once in 30-40 days. The seeds of lucerne are hard and should be scarified or kept in dry heat of 35° C for one hour before sowing at a rate of 5 kg/acre. When grown for the first time they should be inoculated with rhizobium.

Chemical constituents of alfalfa give us an idea of its nutritional value as feed. Lucerne contains crude protein 19.3%, calcium 1.6%, phosphorus 0.26%, copper 6.2, magnesium 0.06, iron upto 0.16, cobalt 0.14, zinc and selenium 8 ppm on dry weight basis per pound.

Alfalfa also contains vitamins B_1 B_2 niacin, choline, folic acid, tocopherol and estrogens in sufficient quantities to meet the needs of cattle and men.

Alfalfa hay proteins are comparable to whole egg proteins with amino acids essential for human health. Arginine, histidine, isolucine, lysine, phenylalanine, threonine, tryptophan, valine and cystine found in alfalfa make it a natural tonic. As it is protein rich cattle should be fed only prescribed quantities. Green shoots are fed to dairy cattle, horses and sheep. It is given in pellet form to swine and poultry. One interesting use of alfalfa is to prevent scale formation in metallic containers employed in industry.

Lucerne can also be cooked as a vegetable and is relishable like *methi.* About 50 gm of cooked alfalfa can be taken in diet every day. The herb should be blanched in boiling water and chopped before serving. In Argentina, the Institute of Nutrition developed 'alfalfa tortilla', fruit saute, croquets and souffu. Alfalfa *puree* is also made to Indian tastes.

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Howrah (W.B.)

The hazards of natural foods

THE plants are endowed with the genetically determined capacity to synthesize a wide variety of chemical substances which are distributed in the various parts of the plant, i.e., root, stem, leaves, flowers, fruits, and seeds as their natural constituents. The dietary value of a plant depends upon its chemical constituents. The plants which have naturally occurring toxic substance are of little value as food and, therefore, are avoided by man and animals. Plants rich in useful ingredients have come into use as foodstuff as a result of human experience since antiquity. The primitive man learnt to avoid the use of plants which produced immediate and unpleasant reactions. Animals also learnt to avoid such plants as a result of experience and instinctive behaviour. The plant foodstuff which however proved harmless came into use by the human beings for several hundred years to evolve into the present day foodstuff combinations.

Here we may think that whatever we eat is safe for us. But researches have proved that even the plant foods which are among the most commonly used may have toxic ingredients in them. However, most toxic ingredients may not produce an immediate violent reaction but may act like a slow, cumulative poison resulting in a disease or affecting normal health. Although the problem of toxicity to man by such constituents is not at times fully appreciated, it has been found that extracts of such plant foodstuff produce harmful effects in laboratory animals. These harmful chemical substances have been extracted from our favourite and delicious vegetables, fruits and cereals, and have been put into various groups on the basis of their physiological properties. These groups are protease inhibitors, hemmagglutinins, goitrogens, cyanogens, cycads, saponins, gossypols, lathyrogens, and allergens. The protease inhibitors are found in seeds of various leguminous plants such as soyabeans and also in other seeds like groundnut, *mung*, rice and wheat. The soyabean protease inhibitors are known to inhibit trypsin enzyme found in the stomach. On experimental animals this has an effect of retarding growth rate and body weight. However, most of the protease inhibitor of soyabean is destroyed by heating or cooking. Hemmaglutinins found in castor seeds have been used as a purgative for long. The castor seed or its oil has the property to agglutinate or clump the blood cells. The cyanogens are glycosides which on hydrolysis yield toxic hydrocyanic acid. The most common glycoside is amygdalin found in almonds; the

bitter almonds are its richest source and hence may prove fatal if consumed in a large enough quantity. A number of deaths in children due to eating bitter almonds have been reported from many countries. The Kola bear found on the tip of eucalyptus trees in Austrialia avoids the use of those leaves which are rich in hydrocyanic acid. And it eats selectively fresh and young leaves which have little or no cyanogen. Cyanogens are also found in other common foodstuffs such as sweet-potato, maize, beans, apples, sugarcane and oranges. Cycads, saponins and gossypols are, however, among the less important toxic ingredients.

The most important toxic ingredients are lathyrogens because several outbreaks of lathyrism in India have been reported from Madhya Pradesh, specially during famine due to abnormal consumption of the lathyrus (commonly known as *khesari dal*). The substance responsible for lathyrism has been identified as an amino acid. The goitrogens are found in the members of the genus Brassica; for example, radish, cabbage, and mustard are among the chief sources of goitrogens. Animals fed on mustard seeds have been found to develop goitre. In Tasmania people who drank unboiled milk from the cows fed on Brassica plants have developed goitre. The goitrogens are known to reduce the iodine absorption capacity of the thyroids.

Several other examples of toxic substances occur naturally in plant foodstuff. Among them, the solanine alkaloids found in potatoes have caused many cases of human poisoning specially under circumstances of unusual consumption involving the potato eyes and skin. Solanine of potato is known to increase if freshly harvested potatoes are kept in open sunlight. Potatoes with solanine concentration above 0.1% are unfit for human consumption. In unripe grapes a glycoside naringen is found which is irritating to gastrointestinal tract. Tomatoes contain a hydrocarbon lycopene related to carotene. Long term consumption of large quantities of tomato juice is known to result in lycopene accumulation in the liver and cause illness in man. The presence of a toxic ingredient in onions has also been reported. It has been observed that raw or cooked onions fed to dogs lead to severe anaemia. It is very likely that people would develop anaemia if they consume 350 gm of onions a day.

In certain circumstances accidental feeding by cattle on certain harmful plants may make their milk fatally injurious. It is reported that Abraham Lincoln's mother died due to consumption of milk from a cow that had eaten white snakeroot (*Apolopapus heterophyllus*). It contains the poisonous unsaturated alcohol, tremetol.

It is clear that we are surrounded by poisons which may be in our foods and in our environment. It must be borne in mind that a biologically important substance is useful to only certain limits of consumption and becomes toxic or harmful when it crosses the threshold limit. So, one should not be ordinarily worried about his food. One should, however, avoid taking too much of any particular article in the food. Today, scientists have started thinking that a good many human problems related to old age and health can possibly be correlated to one's dietary habits. Scientists believe that the same attention should be given to harmful chemical substances that occur naturally in plant food as is given to the additives and pesticidal residues in food.

ZAKA IMAM

Case of male pregnancy

THE burden of bearing and rearing the offspring rests with the female of the species, especially in the advanced groups of the animal kingdom like the mammals. In lower orders the responsibility of females is just that of laying eggs in suitable environment. The eggs and young ones are left to the care of nature thereafter. Instances are however known where the parents exhibit remarkable parental care. The most interesting case in fishes is that of "Sea horse" (*Hippocampus*). Here the females are the liberated ones, the males are burdened with the load of pregnancy.

In sea horse, females lay eggs, but the rearing responsibility entirely rests with the males. The male receive the eggs from the female in brood pouches. They, with the enlarged brood pouches, present a picture of being pregnant The walls of the brood pouch is supplied with blood vessels. The young, when fully developed comes out of the brood pouch by the rupture of its

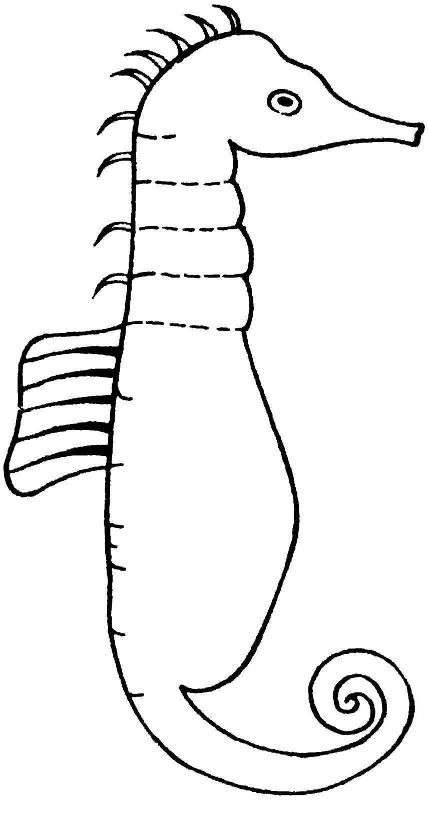

Fig. 1

walls giving a sort of labour pain to their father. No further interest is evinced by the male in the welfare of its young ones A similar phenomenon is also exhibited by Pipe fishes (*Syngnanthus*).

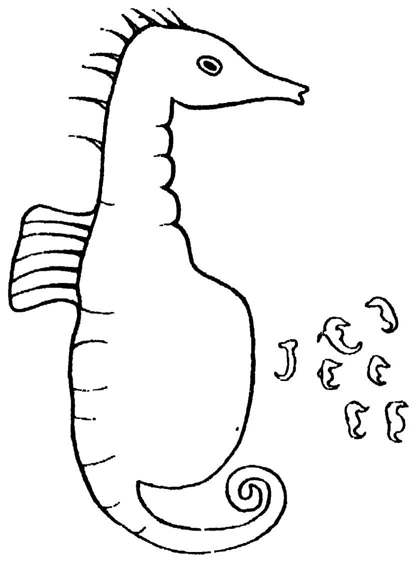

Fig. 2

M. ARAVINDAKSHAN
Central Marine Fisheries Res. Sub-Station, Bombay

The rewarding ruthenium

A member of the transition elements, ruthenium has been in news for sometime past. Its complexes have the peculiar characteristic of mimicking natural catalytic systems ; for example, the active centre of chlorophyll molecule which absorbs sunlight and transforms it into energy, and the plant enzyme, nitrogenase, which converts atmospheric nitrogen into ammonia. Recently, a new use of a ruthenium complex has by chance been discovered by David Whitten, Professor of Chemistry at the University of North Carolina, USA (*New Scientist*, 17th June, 1976). The discovery, if fully exploited and cleared off its limitations, may provide in near future an answer to the existing world energy crisis.

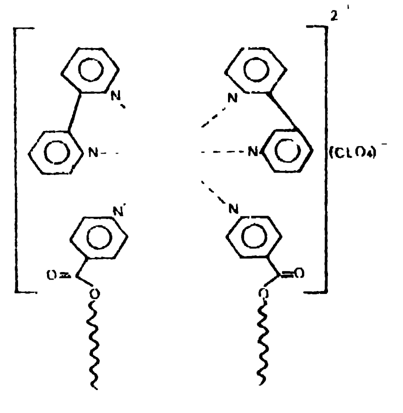

Fig 1. Ru at centre of complex of bipyridyl residues. The long tails (octadecyl residues) help split water

Whitten and his colleagues have found that their artificial compound—ruthenuim bipyridyl residues complex– can split water into hydrogen and oxygen by trapping sunlight. Hydrogen, as it is well-known, is a promising fuel of the future which on use does not add to the pollution. No economically viable technique is available today for generating hydrogen for fuel purposes.

The ruthenium complex (Fig. 1) has two parts; a bipyridyl residues ring structure with ruthenuim in the centre, and long tails of octadecyl residues or dihydrocholesterol attached to the former. The complex, without long tails attached to it, is an orange/red colour substance which can absorb visible light at 377 nm and 430 nm wavelengths. When illuminated it fluoresces with a deep red colour. It is because an electron in the ruthenium becomes 'excited' on absorption of light and rises to a higher energy level. When the electron returns back to its original position, it emits light of deep red colour. Since this complex (without long tails) is soluble, it fluoresces continuously when dissolved in water. It means that the light energy which is being absorbed by the complex is also simultaneously being released.

It was here that the element of chance stepped in. Whitten observed that if long tails are tagged onto the ring, the complex becomes insoluble in water and stops fluorescence. However, it develops a new property; the energy which it absorbs from light is no more released but is rather trapped in some way and can split water into its constituents—hydrogen and oxygen. Actually, Whitten had coated the tailed complex on to a glass sheet, placed it in water and exposed to sunlight. He was surprised to see that a gas containing molecular oxygen and hydrogen was bubbling out. The two components of water existed separately.

According to Whitten, the multicomplex organisation forming the monolayer on the glass may be responsible for keeping the two potentially reactive constituents of water separate. Although the efficiency of this system is remarkably high (quantum yield being 10%) which can further be raised by stacking more monolayers one above the other, Whitten clearly confesses, "We do not know how the monolayer will stand up as a practical system; this is a major problem". Then, economic aspect of the system cannot be lost sight of as ruthenium is an expensive metal.

C. B. SHARMA

The "bright spot" in oil exploration

TODAY oil and gas are world's leading sources of energy. But they have first to be found and brought out of the earth to be of use to us. Finding oil and gas has always been a gamble. The geophysicists and geologists play the odds the same way that an insurance company or a gambler does. For some years now oil and gas prospectors have known that about 7 to 8 of the exploratory wells would produce nothing of value and 1 in 25 will produce enough oil to pay for all costs involved. With the passage of time these odds have turned more against oil prospectors, as the easily found oil deposits have all been discovered.

Now a new method is being used to improve oil prospecting. The new technique is called "Bright Spot" technique. It is a direct means of finding oil and gas without drilling a hole. The technique does not take away all the risks of oil prospecting but it does improve the odds considerably.

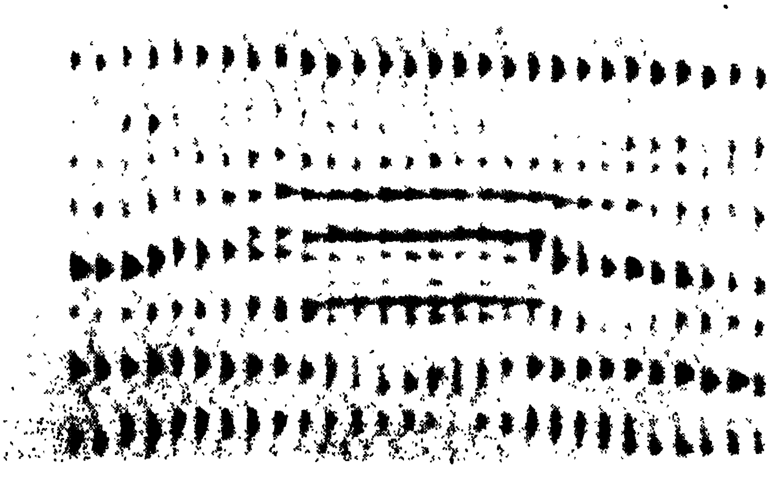

Fig. 1

For nearly 50 years, the standard method of oil prospecting has been based on the seismic reflection. In this method the geophysicist creates a loud sound just below the earth's surface by setting off an explosive charge in a hole or in a body of water. Echoes of this sound return to the surface from various underground rock layers and are picked up by sensitive electronic instruments at the surface.

Complex electronic receivers have been designed to enable geophysicists to detect these echoes and to measure the time taken by them to arrive at the surface. Computers instructed by sophisticated programs translate the reflected signals into pictures of how the earth's rocks would look like if we cut the earth's crust like a layered cake. Such pictures, giving the cross-section of the earth's crust show only the sequence and the shape of the layers. They do not tell us what the layers are made of or what kinds of liquids might be permeating the pores and cracks in the rocks. It is as if we had a line drawing of a layered cake but could not tell which of the layer is chocolate, cake, cream or jam.

From these structural pictures of the layers, geophysicists can make shrewd guesses as to where oil and gas might have accumulated. The maps made by geophysicists from such seismic surveys have over the years improved the driller's odds by a factor of at least 10. With the development of space age electronics in the '60s, it became possible to extract some additional information from the seismic echoes. The new equipment could record the strength as well as the arrival times of the echoes accurately for better interpretation.

Geophysicists have long known or at least strongly suspected that

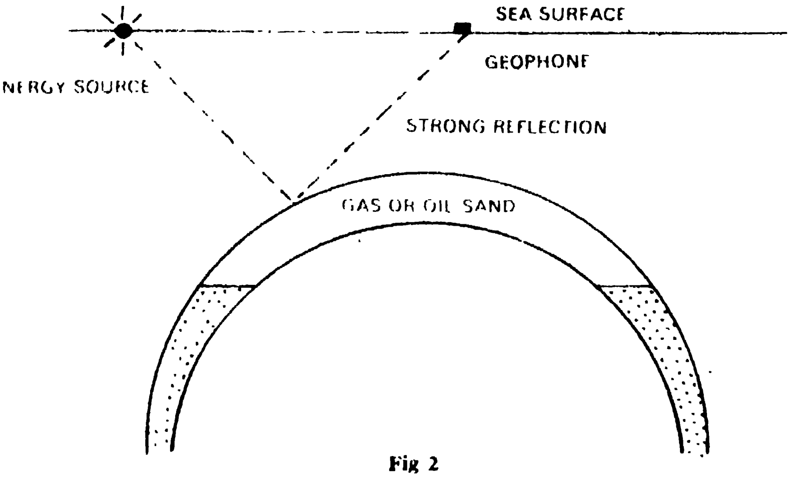

Fig 2

porous rocks, filled with oil or gas, are better reflectors of sound than are the same rocks filled with water.

A sound wave travelling through any medium such as water, air, wood, rocks, etc., continues undisturbed until it reaches some sort of change in the material. When a change of material is reached, a part of sound enters the other material and a part is reflected back. The proportion that enters the second material is the greatest when the two materials are nearly alike. So, in such a case, very little is reflected back. If the two materials are quite different, most of the sound is reflected and very little enters the second material. Sounds in air are strongly reflected by hard walls, cliffs, etc., because they are different from air. Submarine detection by using sound techniques and echosounder works well, because a submarine or the ocean bottom is distinctly different from water and so reflects back most of the sound energy. Sound techniques are also used by submarines to measure the distance from the submarine to the water surface. Because air is different from water, more than 90 per cent of the sound going upward in water is reflected down again. It is this kind of phenomenon which lets geophysicists find oil or gas directly in the earth.

When a geophysicist creates a loud sound pulse in the ground by explosion or some other means, the sound waves travel through many kinds of rocks But to a sound wave one kind of rock is just like another, so that the geophysicist has to depend on only 1 to 2 per cent of the energy reflected back from a typical change in the type of rock.

Most rocks beneath us are full of empty spaces, e.g., pores between grains in sandstones, cracks and shattered places in limestones. Such pores are invariably filled with some fluid, typically salt water. When the openings are filled with oil or gas, the rocks become a valuable object for our oil technologists. The new technique of bright spot has been able to find these oil or gas-filled rocks and can be relied on.

Some gas-filled porous sandstones are, however, more like gas rather than rock ; they send back very strong echoes. They reflect nearly 50 per cent of the sound energy directed towards them.

While the unusual strength of the reflected signal is a sure sign of gas or even oil, there are other confirming indicators. One is a change in the polarity of reflected waves.

To understand polarity we should examine the nature of sound. A sound in air or rock is a series of compressions and rarefactions of the material in which it travels. The material is alternately squeezed or compressed or stretched or rarefied. When the sound in one medium meets another hard medium, a compression is reflected as compression. On the other hand, when it passes through a softer medium a compression is reflected back as a rarefaction. This is what we understand by change in polarity. If the geophysicist notes an unusually strong reflection and the reflection is opposite in polarity from those he sees from the nearby rocks, he can be reasonably confident to claim that he has found gas or oil or both.

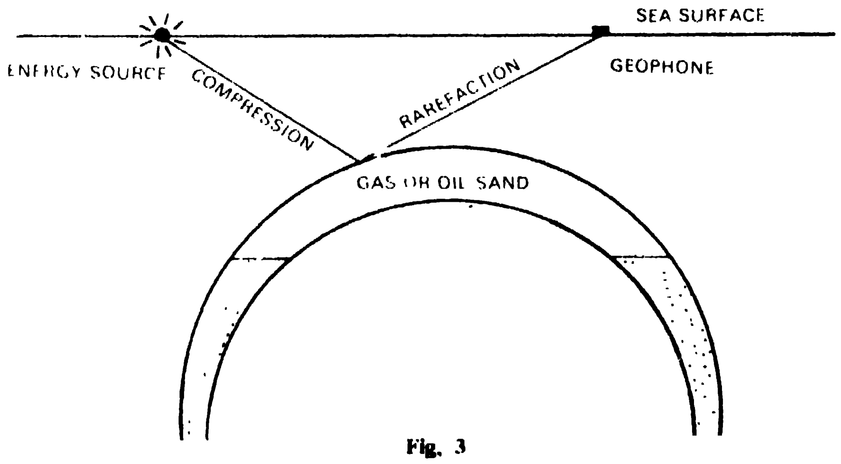

Fig. 3

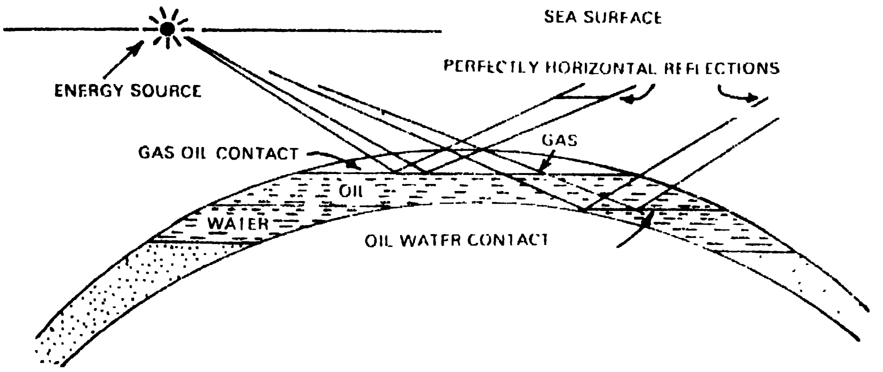

Fig. 4

There is one more characteristic which gives him further confidence. With new instruments and the latest computer programs, he can distinguish between very fine details of reflections. At times he finds a set of reflections which come from a perfectly horizontal surface associated with strong reflections of opposite polarity. Now, in practice, very few geological structures are horizontal, so these horizontal reflections are coming from an interface between two fluids gas over oil, 'or gas over water or oil over water. There is no other possibility and the geophysicist is nearly sure of finding oil or gas or both.

The combination of all these three features—a strong reflection, a change in polarity and horizontal reflectors —is a guarantee for the presence of gas or oil. In Fig 1 all three features are seen in the bright spot in an actual seismic record In the central portion, which appears more prominent than the rest, we can see that the reflected signal is stronger than nearby reflections. Moreover, the polarity has reversed and the three reflections are nearly horizontal indicating gas-oil and oil-water contacts. The same three factors are explained in Figs. 2, 3 and 4.

Scientists first became interested in the bright spot technique in 1960. They concluded that in the process of removing noise from the reflected signals they were destroying the quality of reflections, specially the amplitudes. In 1966, they introduced recording systems that would preserve the information about the amplitude of the received signals. They developed special computer programs needed for this purpose. The investment and the labour paid off in the development of this reliable method of finding hydrocarbons.

The method is being used in India, too. Geophysicists working in Oil and Natural Gas Commission on land and in offshore areas of India, on the seismic ship *Anveshak*, are now increasingly using this method.

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Oil and Natural Gas Commission
Bombay

FOR HER *(Continued from page 193)*

from the surface of the skin, emollients are often added to creams. Spermeceti, cetyl alcohol, vegetable oils and lanolin serve this purpose. Spermeceti, in addition to its emollient effect, makes the cream more opaque and lighter in appearance. 1% cetyl alcohol acts as an emollient and emulsion stabilizer. Care must be taken not to use too much of it, for the cream may soften and become less opaque.

Liquefying cleansing creams

Liquefying anhydrous type of cleansing creams consists of a mixture of oils and waxes designed to liquefy when gently massaged and to cleanse in the same manner as the bees-wax-borax emulsion creams.

The normal creams of this type are translucent in appearance. A more opaque cream can be obtained by adding approximately 2% of zinc oxide, titanium dioxide, magnesium stearate or zinc stearate.

The percentage composition of the cream is as follows :

Mineral oil	65.00 per cent
Petrolatum	12.00 ,,
Paraffin	18.00 ,,
Cetyl alcohol	1.00 ,,
Spermeceti	4.00 ,,

Procedure

Melt the waxes first Add the petrolatum and finally liquid oil. Stir thoroughly, add the perfume at 45°C and pour into jars. The melted product should be strained to remove impurities.

The addition of antiseptics to cleansing creams supports their purpose. Some antiseptics used are 2.2′ dihydroxy, 5.5′ dichloro diphenyl methane and 2.2′ dihydroxy 3.5, 6, 3,′ 5,′ 6′ hexachlorodiphenyl methane.

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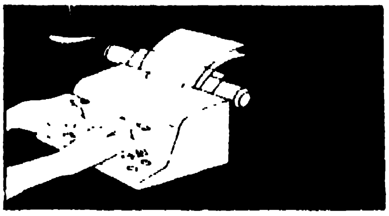

NEWS & NOTES

Agricultural biologist Dr. Lysenko passes away

DR. Trofim D. Lysenko, one of the century's most controversial scientists, whose theories dominated the Soviet natural sciences during the rule of Josef Stalin, died on November 20 at the age of 78. Dr. Lysenko contended that his view that environment could cause hereditary changes in plants was in line with Marxism. Under N.S. Kruschev's rule he was dismissed as President of the Academy of Agricultural Sciences, but made a partial comeback in the latter part of the Krushchev era. After Krushchev's own exit in 1964 Dr Lysenko headed an experimental research station near Moscow. His argument that hereditary characteristics could be changed by the environment was in direct opposition to the classical view that hereditary characteristics were passed along through genes.

Born on September 29, 1898 at Karlovka in the Ukraine, the son of peasant farmers, young Lysenko studied at the Poltava High School and obtained a degree from Kiev Agricultural Institute in 1925. Since 1928 he was concerned with cultivation of new variety of plant forms at the Kirovbad Experimental Station. His first great scientific discovery was achieved on his father's farm near Poltava where he developed the process he called 'yarovzation'' or vernalization of grain. The essence of the process was a kind of preheating or preseasoning of grain that, he contended, would enable crops to be raised with a much shorter growing period and that would also transform the nature of the seed, adapting it to climatic conditions for which it was not orginally intended. Fantastic claims were made of this process in that it could change winter wheat to spring wheat, increase wheat yields up to 40% and make possible in some areas the raising of up to five crops of spring wheat a year. It was also claimed that by using Dr. Lysenko's method tropical plants could be made to flower in the Artic and Subantic. Plant biologists outside Russia noted the sensational assertions and made efforts to test his data. None, however, was successful. Under Stalin, Dr. Lysenko rose to absolute power in Russia's biological sciences. In 1938 he became head of All Union Agricultural Academy; in 1939 a member of the Soviet Academy of Science, and in 1940 head of the Institute of Genetics. He was removed from this post in 1965.

R. K. DATTA
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IV International Heat and Mass Transfer conference

(10-12 Nov. 1977)

The Conference is being organised by the University of Roorkee under the auspices of Indian Society of Heat and Mass Transfer.

The Conference hopes to bring together persons working in the field of Heat and Mass Transfer in various industrial organisations, educational institutions and research establishments in the country and abroad to exchange ideas and information, to critically evaluate the present knowledge and to focus attention on new areas of basic and applied research.

Further information may be obtained from Dr. Rajendra Prakash, Professor, Department of Mechanical & Industrial Engineering, University of Roorkee, ROORKEE-247672.

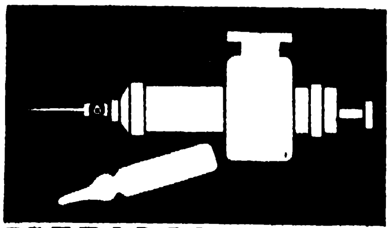
Yant Award for Dr. Zaidi

DR Sibte H. Zaidi who established the Industrial Toxicology Research Centre at Lucknow in 1965 under the aegis of the Council of Scientific & Industrial Research, New Delhi, is a distinguished toxicologist and a world authority on diseases related to industrial dusts.

1977 Yant Memorial Award—established in honour of William P Yant, the first President of the American Industrial Hygiene Association, Ohio—would go to Dr. Zaidi. The Award is given to a person living outside U.S.A. who has made significant contributions in the field of industrial hygiene.

Dr. Zaidi has been invited by the Association to receive the Award at its annual conference scheduled to be held at New Orleans, Louisiana, in May 1977 and deliver a lecture on his contribution to the science of industrial hygiene.

ZAKA IMAM



MEDICAL NOTES

Cancer will touch two-thirds of all families

TWO of every three families in the United States and throughout the world will have some personal contact with the cancer problem. The magnitude of this problem is emphasized by looking at the long periods of time which are involved.

First, there is the period of growth of the cancer itself; secondly, the period over which treatment is administered; and finally, the long period of time during which watchful, expectant follow-up is essential Such follow-up may well involve maintenance of the patient for whom cancer has progressed beyond the point of total eradication. This long period of awareness plus the type of the disease which seems beyond human capability to prevent it produce complex circumstances. Due to this complexity, the diagnosis of "cancer" is one of the most dreaded pronouncements that can be made by a physician. To lessen the awesome impact of this diagnosis, it is necessary that both patient and family understand many of the truths which are not well publicized.

What is cancer? It is a variety of diseases about which we have much information, but we still know little concerning basic problems of its origin. One or another of the various forms of cancer may occur in any tissue of the body. These various forms may have entirely different growth patterns and certainly vary in their capability for producing disability or death. It is essential that one defines the type of malignancy of cancer in any particular case, for previous experience with patients or friends said to have cancer may offer no clue or give a completely false idea of what significance the word 'cancer' carries in a different situation. When cancer becomes a personal problem one deals not with statistics, but with individuals.

Many forms of cancer are curable. This is especially true of the most common form of cancer, carcinoma of the skin. Yet other forms of cancer arising in the same portion of the body may have different needs for treatment and an entirely different outlook for eventual cure. In many instances, concern may be relieved by adequate information There are now more than 1,500,000 living Americans who have been cured of cancer. These have been cured by timely action.

If then action should be taken, where to begin? There are the seven danger signals which appear at the end of this article. These are signs which may suggest the presence of cancer and which are of reasonable concern on the part of any individual. We are today curing one out of every three patients who develop cancer. This could be improved to one out of every two by the application of modern techniques of early detection and adequate treatment. We would need no new information about cancer beyond what we already have. In many cases one can achieve a long period of survival, often with long freedom from symptoms, even though complete cure cannot be hoped for. This survival may well be a product of early diagnosis, for the maximum effect of some forms of treatment can be expected when the tumour is still small. The action begins with early suspicion and diagnosis

There are presently many ways of treating cancers and these vary with the type, location, and stage of spread of the cancer. The principal methods of treatment are aimed at destruction of the initial growth. These treatment programs are almost never undertaken without a proven diagnosis of cancer by examination of tissue or cells from the involved portion of the body. Most frequently, this destruction of the tumour is accomplished by surgery, but radiation may achieve the same effect. After selecting the appropriate form of treatment for the initial lesion, the physician may decide to use one of the many drugs or more recently developed methods of increasing the resistance of the patient to cancer. We are now able to employ in many cases combined therapy, which uses more than one of the basic techniques for treating cancer. The effective treatment of a given cancer thus depends on a knowledge of the various available techniques and the use of the appropriate method.

The treatment does not end with a direct attack on the disease itself. Instead, treatment involves a continuing concern for the return of the patient to a useful and effective life pattern. This might appropriately be called the 'quality of survival', and it is of natural concern for the family as well as the physician. Many special techniques of restoration of physical and social activity are available, but it must be remembered, for the patient with cancer the fear of being abandoned is even greater than the fear of death.

The more prevalent forms of cancer are those seen in the late decades of life. But cancer is not confined to older patients. There are types of cancer which occur predominantly in children, and other types which occur principally in young adults. The frequencies of types of cancers vary between man and women. If we are to achieve our goal of improving early diagnosis and cure, risk factors must be identified and made known to the public. The medical profession is actively concerned with public education, and it has made available through the medical society upto date information.

Much has been written about cancer and our environment. There are many new factors being introduced into our environment by modern technology and industry. There are reasonably effective methods for testing the capability of substances to produce cancer. These methods are in constant use by industry, government and various research institutions. The unfortunate thing is that even in the presence of strong cancer producing agents there is still a 15-20 year lapse before that exposure may produce a cancer. Not until ten years after the heavy smoker quits smoking can he or she expect to return to relatively the same risk of cancer as the non-smoker. This same delay is found in many other forms of environmental cancers, and the need for concern is great. Before any great advances in the control of environmental cancers can occur we must have more information about the basic facts of the origin and spread of cancer. Still, an educated public can avoid smoking, which is associated with 90 per cent of the known environmental cancers.

Then what may be said about the cancer problem in the light of our capabilities today? Cancer is curable in 50 per cent of the cases occurring today. There are four principal methods of treatment: (1) surgery, (2) radiation, (3) chemotherapy (drugs), and (4) immunotherapy (increasing body resistance). These may be used separately, at the same time or in sequence depending on the type and extent of the cancer.

The medical profession is actively involved in education programmes to bring the best and the latest information on diagnosis and treatment to its members; but at the same time, the greatest asset the profession can have is an educated and informed public. This area is one for continuing concern and effort. The future will certainly show great gains in the diagnosis and even prevention of cancer. But the knowledge of the future hopes does not justify neglect or undue fear in light of todays' solutions to many of the problems related to cancer.

Cancer's seven warning signals

1. Change in bowel or bladder habbits.
2. A sore that does not heal.
3. Unusual bleeding or discharge.
4. Thickening or lump in breast or elsewhere.
5. Indigestion or difficulty in swallowing.
6. Obvious change in a wart or mole.
7. Nagging cough or hoarseness.

DR. RAGHUNATHAN
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U.S.A.

Suppression of ethanol withdrawal syndrome

AMONG many neuromuscular withdrawal effects of ethanol are general agitation, tremors, convulsions, hallucinations and delirium tremens. Ethanol withdrawal syndrome is a serious medical problem requiring proper management. Treatment of ethanol withdrawal syndrome focuses primarily on reducing neuromuscular and autonomic hyperactivity. In an attempt to attain this objective in an animal model, Dr. E. Majchrowicz and his associates at the St. Elizabeths Hospital, Washington, D. C. tested 1, 3-butanediol for its ability to suppress an ethanol withdrawal syndrome (*Science*, **194**, 1181, 1976). They rendered male Sprague-Dawley rats physically dependent on ethanol by intragastric administration of ethanol at a dose of 9 to 15 grams per kilogram per day over a 4-day period. They administered a non-intoxicating oral dose of butanediol at 4 grams per kilogram after elimination of ethanol from the blood and found that it was effective against the tremulous and convulsive components of the ethanol withdrawal syndrome in all animals for 1 to 5 hours. Further, this period coincided with the time of maximum severity of the withdrawal syndrome, as seen in the control animals. Whether butanediol can be used in a clinical setting remains to be determined.

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Cleansing creams

THE purpose of a cleansing cream or lotion is to remove facial make-up, surface grime or pigments and oil from the face and throat. Although the use of soap for adequate washing will perform the same function, a cleansing cream has certain advantages. The chemical nature of facial make up is such as to allow quick removal by a cleansing cream. The latter is specifically formulated to dissolve or remove the greasy material holding pigments on the skin.

In addition to the primary function of cleansing, a multipurpose character can be assigned to a cleansing cream by appropriate formulation. The properties required of a good cleansing cream are :

(1) It should be stable and have a good appearance; (2) Should melt or soften on application to the skin; (3) Should spread easily without much drag. During application, it should not make skin greasy or oily. After evaporation of water the cream residue should not become viscous; (4) Its physical action on the skin should be that of flushing rather than absorption; and (5) A light emollient film should remain on the skin after use of cream.

Types of cleansing creams

Traditionally, cleansing creams are classified into two categories. One is usually white or cold-cream type, often referred to as the bees-wax-borax type cream. The other is translucent, liquifying type usually anhydrous in character and consisting of a mixture of hydrocarbon oils and waxes. As a result of the development of the newer emulsifying agents many cleansing creams of the emulsion type are made without using either bees-wax or borax.

Bees-wax-borax emulsion type The bees-wax-borax emulsion represents an important formulation among cleansing creams. The typical creams are usually white, of high luster and free from graininess. The creams have a firm consistency. On application to the skin, they liquefy and spread with ease. These creams contain a high percentage of mineral oil and many of them belong to the oil-in-water type of emulsions. When the creams have been rubbed on the skin sufficient water evaporates to permit phase inversion to the water-in-oil type. With oil, as the external phase, the solvent action of the oil for cleansing purpose is facilitated.

The basic ingredients required for this type of creams are bees-wax, mineral oil, borax and water. Other ingredients are normally added to modify or improve the properties of basic formulation. A generally accepted basic preparation is as follows:

Bees-wax	16.67	per cent
Mineral oil 65/75	50.00	,,
Borax	0.83	,,
Water	32.50	,,

Procedure

Melt the bees-wax and mineral oil together and bring the mixture to a temperature of 70°C. Dissolve borax in water and heat the solution to 70°C. Add the water phase to the oil phase with rapid stirring. After the addition of water, agitate the mixture slowly while cooling. Add the perfume at 50°C. When the cream has cooled down to 42°C fill it into jars. This procedure can be followed for more complicated bees-wax-borax formulations.

Basic materials

Bees-wax is an important factor in determining the quality of cream. It is a raw material of natural origin and is the purified honey comb of the bee, free from all other waxes. It is nearly 80% myricyl palmitate with a mixture of hydrocarbons, 5% of some of the alcohols of C-26, C-28 and C-30 series occurring as esters, and about 10% of higher fatty acids referred to as cerotic and melissic acids. Its colour varies from light-yellow to dark-brown. It is easily bleached either by sunlight or by chemical agents. The melting range of this material is 62°C–65°C with acid number ranging from 17 to 24. Bees-wax does not develop rancidity. It is neither an irritant nor a sensitizing agent. The commercial bees-wax normally used for cleansing creams is of bleached white grade.

Mineral oil is a hydrocarbon that is stable, inexpensive, and not subject to rancidity and odourless. It is a good solvent of oils and greases. The cleansing power of a cream is related to its mineral oil content. Mineral oil has the advantage in that it can be absorbed by the tissues of the skin when retained on the skin for long. Mineral oils suitable for cleansing creams are of light and medium viscosity grades.

The amount of borax used is an important factor in preparing a satisfactory cream. The calculated quantity of borax is necessary to neutralise the free acid present in the bees-wax. Insufficient quantity of borax will result in a dull, grainy cream. Excess of borax can cause the formation of hard, sharp crystals of boric acid resulting from limited solubility of boric acid in the waterphase.

Since mineral oil removes an appreciable quantity of natural oil

(*Continued on page* 189)

SCIENCE FOR THE YOUNG

Wolves of the insect world

WHEN we talk of wolves, the picture of a ferrocious, carnivorous animal immediately comes to our mind. But there are "wolves" in the insect world too, and some species of insects behave like wolves, for example, the mantis.

There are a thousand different types of mantis and they are found in almost every part of the world. They are also known as 'devil's horses' or soothsayers. Literally, the word mantis means diviner. The ancient Greeks believed that the insect was able to see into the future. In some Muslim countries, it is believed that the mantis always prays with its face towards Mecca, thereby implying that it is a pious animal.

The body of a mantis is slender. Usually it stands on its four hindlegs with the frontal pair of legs held together as if in prayer. The frontal legs are actually the grasping organs, adapted for seizing and holding preys. The mantis is probably the greediest of all insects and is always in quest of living preys.

The best way to learn the habits of mantis is to watch one. The insect has well developed wings but it seldom uses them. Normally it sits on twigs of plants, alertly waiting for a prey. When awaiting motionless, the insect appears to be a part of the plant it is sitting on, owing to its green or brown coloration. When the prey comes within striking distance, the mantis starts slowly and imperceptibly moving towards the prey. Reaching it close enough in a twinkling of an eye, the grasping forelegs are shot out, and the next moment the prey is tightly grasped The insect then starts drawing the victim closer to its mouth, and in no time the whole prey is devoured. With the victim thus disposed of, the forelegs are cleansed; the mantis peers this and that way for a while and starts moving further afield in search of fresh preys.

The love life of the mantis is short and snappy. After a brief honeymoon, the insatiable female kills and devours her mate, who is smaller than herself in size. This fact was noted in 1886 by Riley who wrote: 'It is a well-known fact that the male insects of the family *Mantidac* approach the female at the risk of life". The male of an American species, ***Stagmomantis carotina***, was seen by Dr Coleman, an Entomologist, with its head, forelegs and a good portion of the thorax devoured by the female. The male which seemed in no way inconvenienced while being preyed upon by the female, remained quietly engaged in the copulatory act while the female continued her meal. Coleman interrupted the copulation by pulling aside the abdomen of the male; but no sooner the abdomen was released than the male came to his original position and proceeded with covering the female as it did before disturbance.

Mantis can eat a tremendous amount of food. Normally it feeds on grasshoppers, other insects as well as spiders. But it can also kill animals bigger than itself. The ferrocity of the mantis is proved by the note of Maj. Browne published in the Society's Journal (*J B N H S*, Vol. 12: 579; 1899): A small sunbird (*Nectarinia minima*) happened to come hovering about a branch on which a mantis (*Hierodula bipapilla*) was biding its time. The mantis struck out at the bird with its forelegs and scalped it, which made the bird drop dead. The incident was recorded from Dharwar (Karnataka).

There are some mantis who display a fantastic camouflage. An interesting example is offered by the roseleaf mantis of India which can verily be called a 'wolf in sheep's clothing'. This mantis has an expansion along its body sides and the legs resemble the shape of leaves. The insect is green in colour but the underside is tinted a beautiful pale lavender violet. The insect hangs with its head down wards among the green foliage and swings lightly in the air currents every now and then, like a leaf or a flower, to strike at an unwary victim.

Not much work has been done on feeding habits of Indian species of mantis, What is now required is careful observation of their food habits to establish their economic importance in biological control of agricultural pests.

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The inspector's trickery

LAST week, an inspector from Health Department came to me to collect records of my family members. He was, to my wonder, a funny mathematician too. When I was about to tell the number of my sons and daughters, he stopped me and asked,

"Write down the number of letters in the word 'DAUGHTER' times the number of sons that you have.

(1) Add to it the number of letters in 'SON' times the number of our daughters;

(2) Multiply the result by the maximum number of children that a married couple may have under the new family planning instructions (i.e.; 3)

What was the trick ?

(3) Subtract the number of letters in 'SON' plus 1 times the number of your sons; and

(4) Subtract the number of letters in 'DAUGHTER' minus 1 times the number of my daughters."

The trick

We know that the number of letters in 'SON' is 3, and that in 'DAUGHTER' is 8. Let s be the number of sons, and d the number of daughters.

We make an algebriac expression following the statements of the trick, and find that

$$3(8s+3d)=4s-7d$$
$$=20s+2d$$

(20s+2d) was the answer I gave to the inspector.

Dividing this answer by 2, we will get $10s+d$, which is equivalent to a number having s in the tens place, and d in the units place. So we have reached our goal (the numbers s and d).

For example, if I had 4 sons and 5 daughters, I would give him the figure 90. He, then, simply has to divide my answer by 2, which yields 45, and get the solution FOUR FIVE, that is, 4 sons and 5 daughters.

The trick will always be true, of course, for s and d less than 9.

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District Jail, Lucknow U.P.

Series of 'Ologies

AGROLOGY : Science that deals with the soils especially in relation to crops.

Agrostology: Scientific study of grasses.

Algology: Science that deals with algae.

Anthropology: Science that deals with the man in relation to distribution, origin, classification and relationship to races.

Archaeology: Scientific study of material remains of past human life and activities.

Archology: Science that deals with government.

Astrology: Science of the influence of stars on human and terrestrial affairs.

Bacteriology: Science that deals with bacteria.

Biology: Science that deals with living organisms.

Cardiology: Scientific study of heart and its action.

Cartology: Science that deals with maps and charts.

Chronology: Science of computing time.

Climatology: Science that deals with the climate.

Cosmology: A treatise on the structure and parts of the systems of creation.

Criminology: Science that deals with crimes and criminals.

Cryptology: Science of secret language.

Cytology: Part of biology that deals with cells.

Dermutology: Science that deals with skin.

Ecology: Science that deals with the living organisms in relation to environment.

Embryology: Science that deals the embryo.

Endocrinology: Science of ductless glands.

Enology: Science that deals with wine and wine making.

Entomology: Science that deals with insects.

Etiology: Branch of science that deals with the causes.

Ethiology: Science of character of bionomics.

Ethnology: Science that deals with varieties of human race or cultural anthropology.

Etymology: Science of linguistics that deals with the deviation and original significance of words.

Geneulogy: Science of history of descent of families or pedigree of a particular person.

Geology: Science relating to the history and development of earth crust with its successive flora and fauna.

Gynaecology: Branch of medicine that deals with women.

Histology: Science that deals with minute structures of tissues.

Hydrology: Science dealing with the properties, distribution and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere.

Ichthyology: Branch of natural history that deals with fishes.

Immunology: Science that deals with immunity (resistance).

Lichenology: Science of lichens (fungus-alga association).

Meteorology: Science that deals with weather and atmosphere especially with the weather.

Microbiology: Science that deals with microscopic living organisms.

Minerology: Science of minerals.

Musicology: Science of music.

Mycology: Science that deals with fungi.

Necrology: Obituary.

Nematology: Science that deals with nematodes.

Neurology; Science that deals with the nerves and their function.

Numerology: Science that deals with the numbers.

Ontology: Branch of metaphysics relating to the nature and relation of being.

Ophthalmology: Science that deals with eyes.

Palaeontology; Science of fossils.

Palynology: Science that deals with the spores and pollen grains.

Parasitology: Science that deals with parasites.

Pathology. Science that deals with diseases.

Pedology: Science that deals with the soils.

Philology: Science of language.

Phycology: Science of algae

Physiology: Science that deals with the processes of life.

Phytology: Science of plants (Botany).

Pomology: Science of fruits.

Radiology: Science of radioactivity and radiation.

Serology: Science that deals with serums.

Technology: Science that deals with the techniques or methods in any branch of science.

Terminology: A set of terms used in any part of science.

Thanatology: Science that deals with earth.

Toxicology: Science that deals with toxins

Urology: Branch of medicine that deals with urogenital tract.

Virology: Science that deals with viruses.

Xylology: Study of structures of wood.

Zoology: Science that deals with animals.

Zymology: Science that deals with fermentation.

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Do it at your home :

Battery eliminator

YOU must have seen battery eliminators displayed in shop windows. They range in price from Rs. 14 for a small one to Rs. 75 plus. But have you realised that you can make one at home at a fraction of the market price without any sacrifice in quality? In this issue we shall describe how to make a small 6V eliminator.

The circuit given in Fig. 1 represents the simplest eliminator that you can make. It consists of three portions: the transformer, the rectifier diode and the filter capacitor. What the transformer does is to convert 230 volts AC into 6volts AC. The diode now steps in. A diode is a device that allows current to flow only one way, i.e., it acts as a valve. So the AC which till now was sinosoidal as shown in Fig. 2, will now appear as shown in Fig. 3.

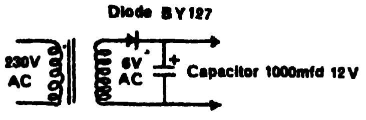


Fig. 1

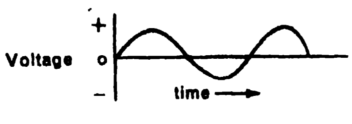


Fig. 2

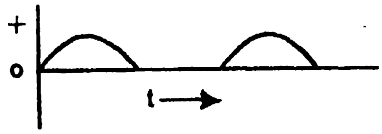


Fig. 3

This is unidirectional current. However, it is not DC. It can be thought of as the sum of a bit DC and a bit AC. If we take the circuit as that it becomes easier to understand the function of the capacitor. We have only to remember that a capacitor has low resistance to AC and infinite resistance to DC. As a result, the AC component is shot-back and the DC goes through. So we have thus an eliminator that can give 6 Volts DC. If we now modify this circuit, we can get still better DC. At the moment we are wasting the portion below the 0 volt line in the AC diagram (Fig. 2). By substituting a different rectifier circuit, that portion can be used. Any of the circuits shown in Fig. 4 can be used.

The circuit (i) (Fig. 4) is called a full-wave circuit. It, however, needs a special kind of transformer which has a tap on the secondary and is made such that the output voltage between the centre-tap and either end is 6 volts. The circuit (ii) is called a bridge circuit. It uses an ordinary transformer.

The second improvement that we can incorporate into our eliminator is in the filter circuit. If we add a choke (an inductance) to the output, the output is a far better DC than we otherwise get. It is because the inductance has higher resistance to AC than DC. As a results it lets the DC through but not the AC. This is known as an LC (L stands for inductance and C for capacitance) filter.

The circuit for making a simple battery eliminator is shown in Fig. 5.

where T: Transformer which converts 230V in to 6V. Current rating 200 milliamperes to 500 milliamperes depending upon the use intended.

R: Rectifier bridge stack. This has four pins and is built so that you don't have to worry about how to connect the diodes. Two of the pins will have yellow dots on them. Connect the wires from the transformer to them. Two of the other pins will be interconnected and will have a black dot. This is the negative output. The pin that is left will have a red dot on it. This is the positive output.

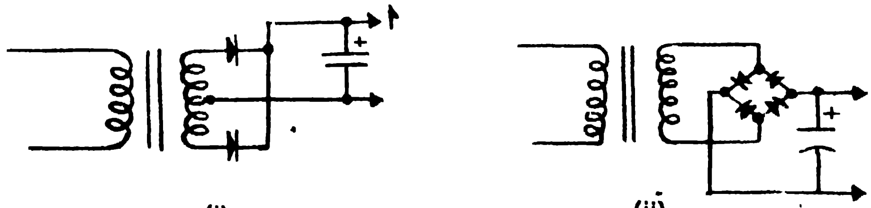
C: Electrolytic capacitor 1000 mfd 12V. Remember that the longer lead indicates the positive end indicated by + in the circuit diagram.

L: Inductance (It is better to say 'choke' to the shopkeeper) 100 milli Henries.

S: Toggle switch for on-off 230V 2Amp.

B: You can put in a bulb here. Use a 6.3V bulb.

You will also have to buy a mains lead wires for the output (red for positive and black for negative) and a box to house the whole thing.



(i) (ii)

Fig. 4

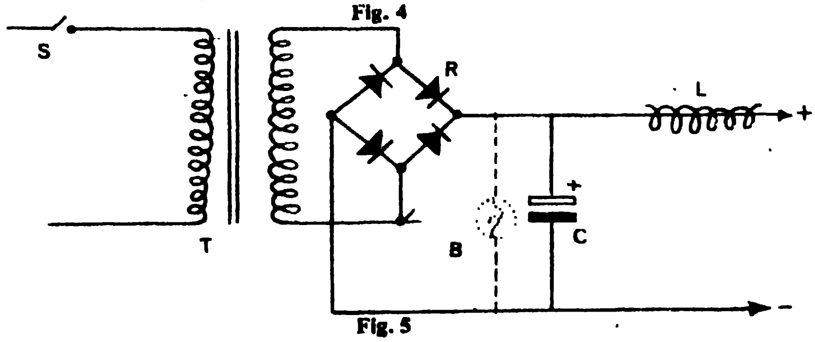


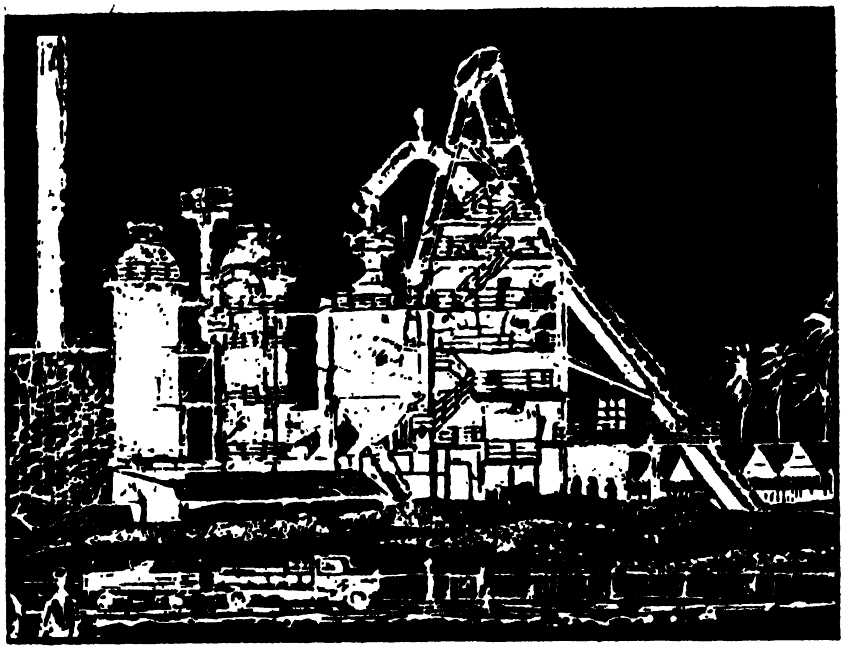
Fig. 5

Usual prices of the items are as follows:

Transformer	Rs. 3.00
Bridge	Rs. 2.50
Capacitor	Rs. 1.60
Inductance	Rs. 1.50
Toggle switch	Rs. 2.00
Mains lead	Rs. 1.50
Output wires	Rs. 0.60
Box	Rs. 3.00
	Rs.15.70

These are the maximum prices. Your expense will probably be

(*Continued on page* 161)



SCIENCE IN INDUSTRY

Useful know-how developed by National Physical Laboratory

SIGNIFICANT contributions have been made in applied research and development work by the National Physical, Laboratory, New Delhi for the industrial growth of the country. As a result, production worth Rs. 15 million is being carried out by the licencees based on the NPL knowhow. About 70 new products and processes have been developed.

Electrostatic photocopying machine of electrofax type

The machine is an automatic electrosatic photocopying machine using sensitized ZnO coated paper capable of copying documents in about ten seconds. It consists mainly of the following:

1. ZnO sensitized paper feeding system, 2. Charging system using corona discharge, 3. Optical system, 4. Developing system, 5. Developer, and 6. Fixing system.

The developer and the sensitized paper are the only consumables.

The machine is versatile, very small in size and very useful for copying work. The machine may cost around Rs. 10,000/- compared with the price of a similar imported machine which costs around Rs. 20,000/- or even more. A manufacturer can easily sell 200 machines per annum earning Rs. 20 lakhs.

The working of the machine has been demonstrated to visitors.

The interest shown by the people and seeing the facilities provided in the advanced countries, it is felt that thousands of machines would be needed in the country. The machine would also have export potential.

The process knowhow for the ZnO sensitized paper has already been released to the industry and it is expected that this paper would be available in the market soon.

Carbon thrust bearings

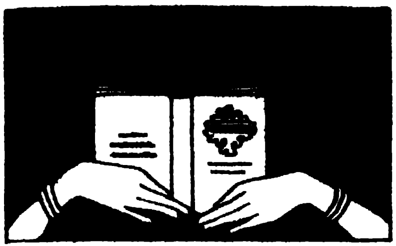
Process knowhow has been developed by the National Physical Laboratory, New Delhi for manufacture of carbon thrust bearings for automobiles. At present these bearings are being imported and their demand is estimated at 2 lakhs pieces per year and their production would save a few lakhs in rupees in foreign exchange. The samples made at NPL were tested in the NPL vehicles and their performance was found to be quite satisfactory and the product meets the specifications. All the raw materials like petroleum coke, coal tar pitch, carbon black, synthetic graphite, natural graphite, etc. are indigenously available.

Electrographite carbon block for automobile generator

A process for manufacture of electrographite carbon brushes for use on automobile generators has been developed. It is an import substitution based on raw materials indigenously available. The product has been tested and found satisfactory. It would save foreign exchange amounting to a few million rupees.

The process utilises mainly graphite and carbon block mixed together with coal tar pitch as a binder material. The mixed mass is moulded and given low and high heat treatments. The process has been worked out on laboratory scale and would be of interest to people desirous of setting up a small scale industry for carbon product production.

The annual requirement of such brushes is about 50 tonnes and their indigenous production would save a few million rupees.



BOOK REVIEWS

PRINCIPLES OF ENGINEERING THERMODYNAMICS by E.M. Goodger, *The Macmillan Press Ltd.* (1974); Representative in India: 2/10 Ansari Road, New Delhi-110002, Pp. xiv+194, £ 2.95.

THERMODYNAMICS deals with the study of heat and its relationship to the other forms of energy such as mechanical, electrical and chemical. This subject is of interest to students of physics and engineering. While physicists are interested mainly in the fundamental concepts, engineers are concerned with their applications. This book is of help to the latter.

The first half of the book has been devoted to the topics like thermodynamic considerations of energy forms, energy transfer and energy conservation. Thereafter physical properties of the fluids have been discussed. Finally different thermodynamical processes and cycles have been dealt with. The book also contains a small note on systems of units, conversion tables for units of different systems, glossary, bibliography, etc.

The text of the book has been well written and properly illustrated. Numerical examples have been discussed at various stages. Every chapter ends with a set of test questions and a number of good problems whose solutions have been given at the end. After each test question, reference of the relevent portion of text to which the reader should consult in case he is unable to answer has been made. Students will undoubtedly be benefited by such an arrangement.

The book is concise, and only the main principles of the subject have been identified and explained. However, essential details have not been missed as promised in the Preface. The book will definitely be useful to the undergraduate students of engineering for whom it has been written.

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SCIENCE IN ACTION (Parts I, II, III, IV) by Meera A. Parasnis, *The Macmillan Co. of India Ltd.*, 2/10, Ansari Road, Daryaganj, New Delhi-110002, Rs. 4.80 (I), Rs. 5.25 (II), Rs. 6.00 (III), Rs. 7.00 (IV).

TO draw a child's attention towards science, an appropriate atmosphere has to be built around him. What else could be more captivating than a miniature scientific laboratory at his hand, where he could conduct experiments as and when he likes? In Indian homes, however, such atmosphere is a rarity. The so-called "Science Kits" available in the market are so costly that only a privileged class of Indian society can afford them for their children. Naturally, other children have to satisfy themselves with "blackboard experiments".

The books under review serve to make up for this situation by bringing scientific experiments to the home of almost every school-going child. The authoress, who is the Principal Coordinator, School Science Materials Projects, Education Development Center, I.I.T., Kanpur, has done a good job by using her 10-year involvement with children to bring out this series of books. Every experiment, she claims, has been "tested in life".

The books, indeed, in the experiments, cover all the principles which are to be learnt in classes, so that while doing experiments the child learns as well. Firstly, every experiment has been given a catchy heading, and the procedure, as desirable to a child, has been laid down in a stepwise manner. To "stimulate thinking", a question about the "Why" of the experiment has been put in at the end of every experiment. Answers are given at the end of every book.

The significant feature of the books is that not only the material required in the experiment, as claimed, is "easily available and low cost", but also it could be made available at home; for example, materials like jam, milk bottles, coffee tins, paper cartons, drinking straws, etc. Wherever needed, makeshift material has been mentioned. For instance, it has been told that metal foils can be had from coffee or tea tins, box from a shoe container.

The covers of the books are, however, gaudy and won't catch the attention of young minds. Illustrations are also shoddy. Letting these two factors aside, the books are worth possessing for any inquisitive child, preferably in the age group 8-13.

DILIP M. SALWI

NUMERICAL PROBLEMS IN CHEMISTRY by N. N. Sarin and R. N. Sarin, *Sultan Chand & Sons*, New Delhi, 1976, Pp. 448, Rs. 7.00

THE study of a scientific principle remains incomplete unless its applications in the form of numerical problems are extensively done. Such problems, on one hand, provide a good drill to the students and, on the other hand, can be thought-provoking. The changing pattern of examinations, university as well as competitive, where more of short numerical problems are asked, is in keeping with the above view.

The book under review is intended to serve as a textbook on numerical problems in chemistry for Higher

Secondary, Intermediate and other equivalent examinations. Running in its twelfth edition, it deals with numerical problems and their principles related to physical, inorganic and organic chemistry. This small, comprehensive book is divided into twenty one chapters, which covers different topics on chemistry taught at pre-university level of mostly all Indian Universities. The principles underlying the problems have been explained at the start of every chapter, which helps the students to refresh their understanding of chemistry. In every chapter, a number of solved examples have been cited. Diverse types of unsolved problems have been added to make students understand the principles involved more thoroughly. Examples and exercises have been selected largely from latest examination papers of Universities, Boards and I.I.T., etc. The book can be recommended for both weak and average students who are appearing for competitive examinations as well as those who would like to use it for their regular studies.

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MODERN PHYSICS by N. K. Seghal, K. L. Chopra and D. L. Sehgal, *Sultan Chand & Sons*, Delhi, Second Ed., 1976, Pp. xi 472, Rs. 12.50.

THE book, though entitled "Modern Physics", is on atomic and nuclear physics. It is divided into three parts. The first part contains an introduction to the theory of relativity; the second part consists of eight chapters dealing with atomic physics; while the third part, again in eight chapters, is about the nucleus of an atom. At the end, there are seven appendices which deal with some portions of solid state physics, quantum mechanics, atomic and molecular spectroscopy, and contain some solved problems from latest university question papers.

The book is quite detailed and is well illustrated. Each topic has been built up from the beginning, giving a historical background, which is more than required. Many different methods are discussed for the measurement of each physical quantity. One usually does not find so many methods in a book of this type. Frequent use of S. I. units has been made. After each chapter, a large number of solved problems, questions, and a list of references for further reading are given. Questions are of three type: essay-type, objective-type and numerical problems. Objective-type questions are mainly of the fill-in-the-blanks type. Apart from self evaluation, these questions, coupled with their answers, would also help the students in taking a quick review of the material given in any particular chapter. The book also contains some very useful information on physical constants, nits, symbols and various conversion factors.

In some sections, there is a lack of proper emphasis on important points. This may create confusion in the mind of an average or below-average student. Moreover, the subject matter could have been written in a more comprehensive way; some portions need improvement to enhance the clarity of the subject.

The reviewer fails to understand the reason for making a separate part for the theory of relativity in a book dealing with atomic and nuclear physics. Introduction to relevant portions like the mass-energy relationship and the relativistic correction to mass could have been given wherever mentioned for the first time, or in an appendix alongwith the other copies. If, however, the book is truly on modern physics, then other fields like astrophysics, plasma physics, low-temperature physics, to mention only a few, also need, their due share of discussion.

The utility of this book, compared to other books, is enhanced as its text material is frequently borrowed from some standard western books on the subject. This, coupled with its price, is likely to make it popular with the Honours students. Further, it would be a valuable aid for candidates appearing in advanced professional and competitive examinations. The pass course students may, however, find the detailed treatment quite irritating. They have to be little smart in picking out the important points from the unimportant ones.

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BOOKS RECEIVED

THE PENGUIN DICTIONARY OF PHYSICS by Valerie H. Pitt, *Penguin Books*, Representatives in India: Penguin Overseas, 706, Eros Apartment, 56 Nehru Place, N. Delhi-110024, Ppl 428, £ 2.

AN INTRODUCTION TO FLUID DYNAMICS by R.K. Rathy, *Oxford & IBH Publishing Co.*, 66, Janpath, New Delhi-110001, Pp. 684, Rs. 24

SPICES AND CONDIMENTS by J.S. Pruthi, *National Book Trust*, A-5, Green Park, New Delhi-110016, Pp. 270, Rs. 14.50.

MEDICINAL PLANTS OF INDIA, Vol. 1, published by *Division of Publication and Information*, Indian Council of Medical Research, Ansari Nagar, P.B. 4508, New Delhi-110016, Pp. 487, Rs. 30.

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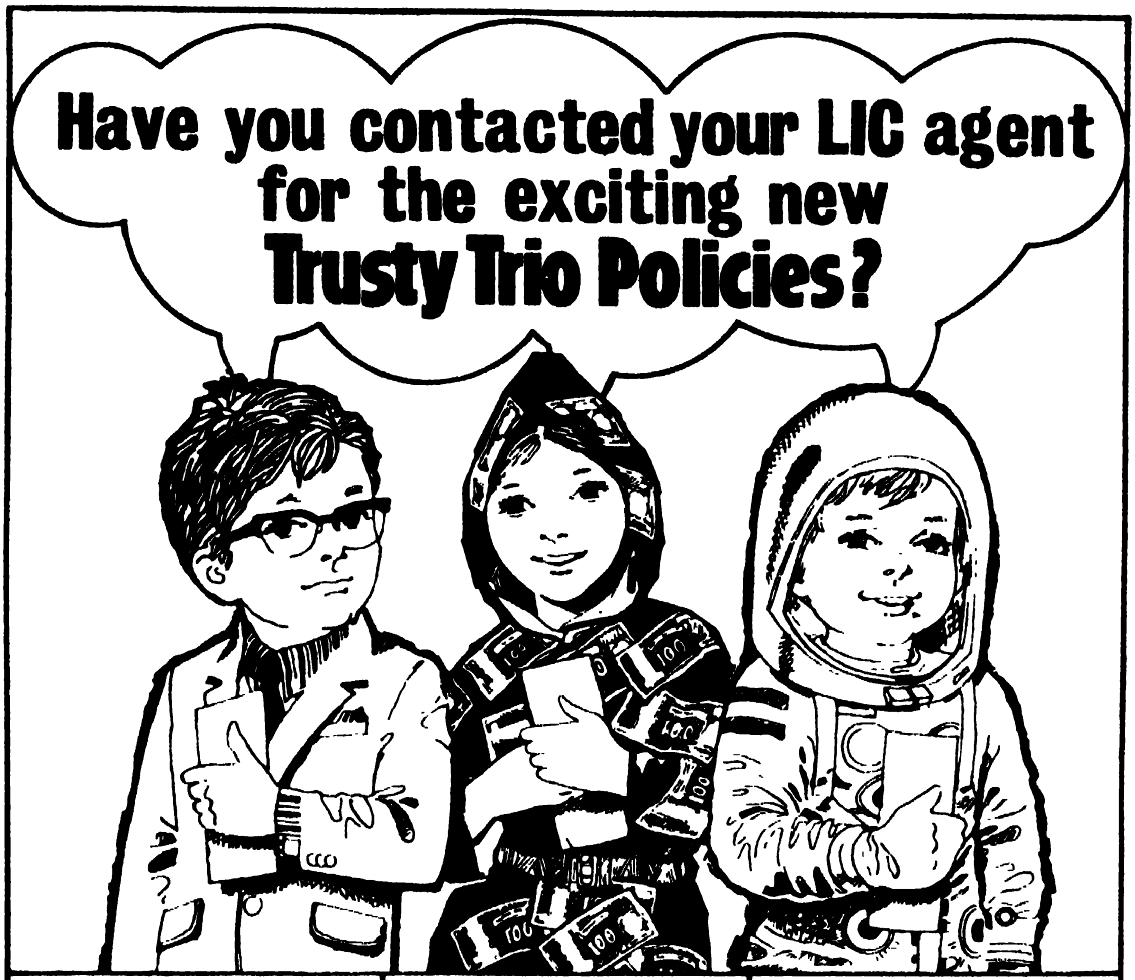
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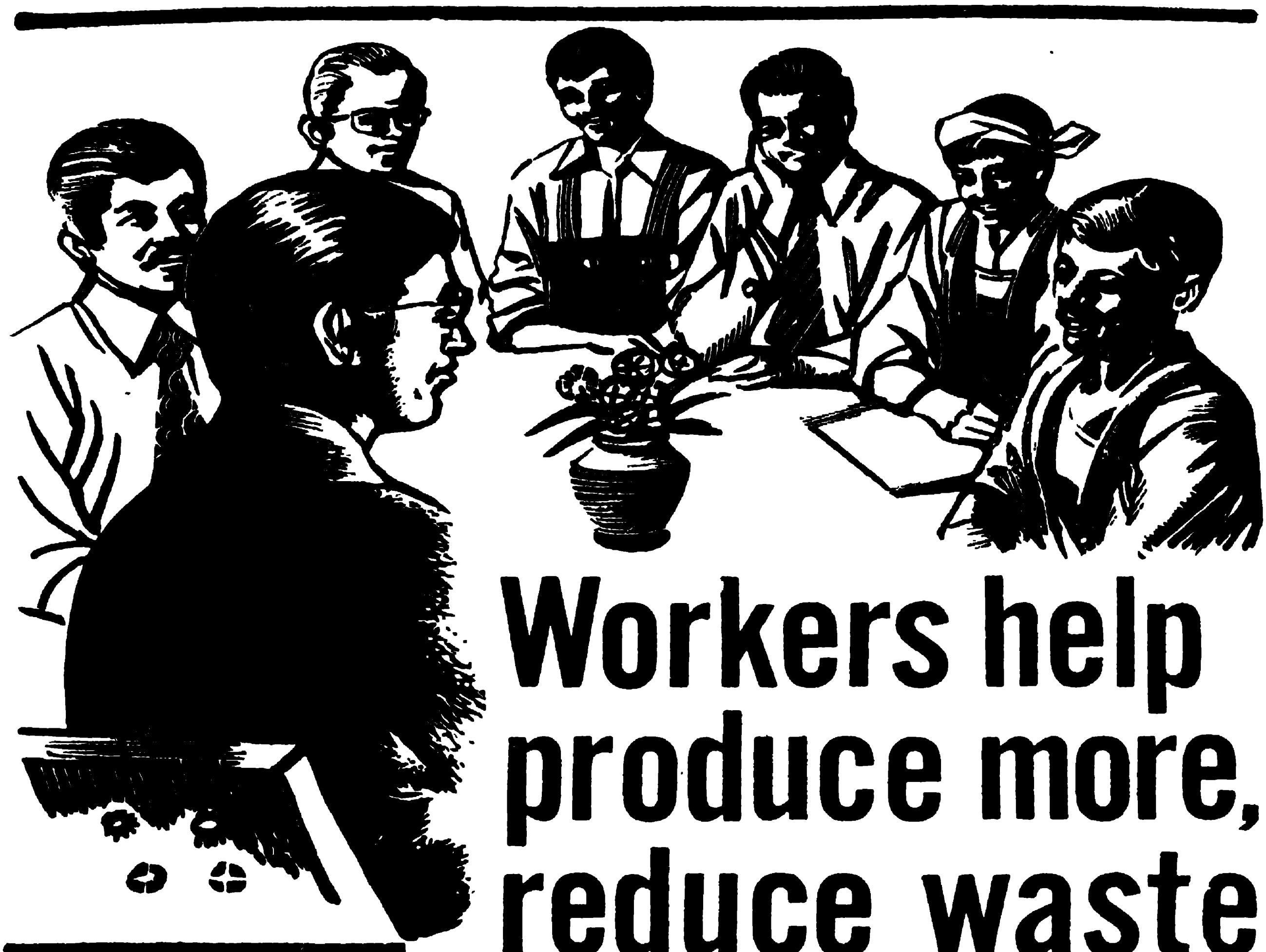

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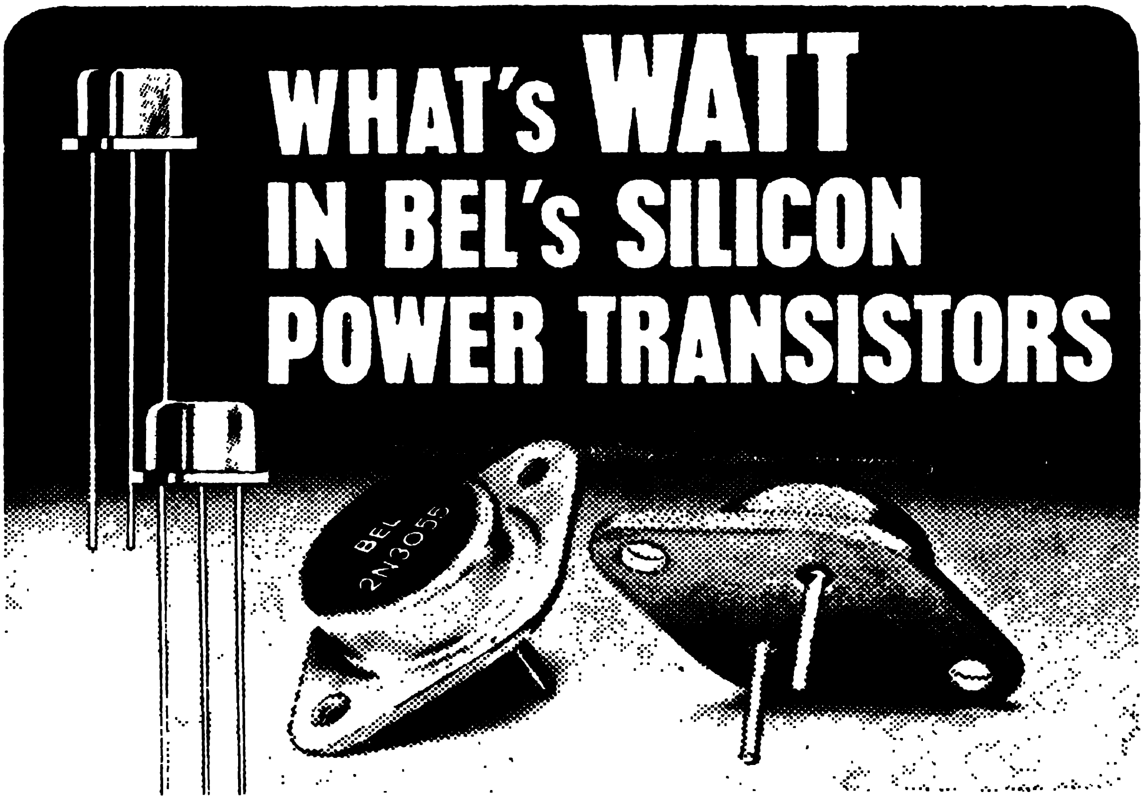

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Our New Prime Minister

NO other person in recent history of the world has perhaps seen a life of greater struggles and successes than Shri Morarji Desai, our new Prime Minister. Also, no other person has spoken so rarely about his sufferings and sacrifices than Shri Desai. In a country where self-adulation and self-publicity of one's own family had become too familiar a refrain, Shri Desai stands as a refreshing contrast. During the struggle for India's freedom, Shri Desai suffered physically and financially, and was in jail for seven years with nothing for his family to fall back upon. In line with his philosophy of life, Shri Desai has not sought publicity of these sacrifices nor has he tried to make political capital out of them. He has been a true follower of Gandhi throughout his life. He has not used power for self-interest. On the other hand, he is recognized even by his opponents as an absolutely incorruptible and transparently frank person. He leads an austere life which has no room for hokum and hypocrisy. It is fortunate that the country has such a seasoned and honest person as its Prime Minister. CSIR is lucky to have him as its new President.

Shri Desai's interest in science is natural, because he is a scientist by education. As Deputy Prime Minister and Finance Minister, he was a Member of the CSIR Governing Body until 1969 when he resigned from the Government.

In connection with the Governing Body meetings of the CSIR, I had a few occasions to see Shri Desai. He had wanted more information about some projects which were to be discussed in the Governing Body. When I went up to him to provide the detailed information, I started giving him the background information about the projects. He cut me short, and reminded me that he wanted precise and specific information on the points he had indicated on the papers. I had then the personal experience of the fact that he always did his homework thoroughly so that his time with officials is not wasted. He was always sympathetic to the CSIR and the cause of science. During the difficult economic days of the late 60's, he, as Finance Minister, spared CSIR the financial stint which other sectors had had to suffer. With India having for the first time a scientist as Prime Minister, there is no doubt that science and technology will get the much needed direction and leadership and scale new heights.

S. P. A

LETTERS

Divisibility rule

Sir, The rule for divisibility by ten (10) need not be stated as it is too simple and evident (*S.R.* Nov., 1976).

While dividing by two, we can also state what the remainder would be.

Rule : If the last digit of a number leaves a remainder 1, the whole number will give the same remainder when divided by two.

Similar rules for powers of two like four, eight, etc., follow.

Rule : If the last two digits of a number give a remainder R, the whole number will give the same remainder when divided by 4. *Example*: 102543: the last two digits 43 leave a remainder of 3 when divided by 4. Hence the remainder after dividing 102543 by 4 is also the same, viz, 3.

When a number is divided by, 3 or 9.

Rule : Total the digits in the number and divide that number by 3 (or 9). Let the remainder be r. Then, the whole number when divided by 3 (or 9) will give the same remainder.

Example : Consider 4541. Adding the digits, we get a total of 14. This divided by 3 gives a remainder of 2. Hence, the number also leaves a remainder 2 only when divided by 3.

Now, let us divide by 9 ; 14 leaves remainder of 5. Hence, the number 4541 also leaves the same remainder when divided by 9.

The divisibility rule by 11 will not admit of a method to find the remainder.

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Breathing and posture

Sir, **Breathing is related to your posture** (*S.R.* December, 1976) prompts me to add some observations regarding the phenomenon. Facts and figures presented in the article regarding the amount of air inhaled through the right and left nostrils no doubt reveal an exhaustive study, but the phenomenon of differential air exhaust is observed in the same posture also and it varies with the time of the day as well as the health conditions of the body. In fact, rarely equal amounts of air pass through the two nostrils. Such an equalisation is almost unattainable and this is known to result in a perfect equilibrium of mind.

Some Yogic therapists claim to prevent the attack of ensuing diseases by a forced change in the direction of the nasal air flow. They also claim that the following (Table 1) schedule of flow is supposed to aid in healthy functioning of the human subsystems.

Even the flow should preferably be controlled during excretion of stool and urine.

These apparently queer prescriptions need proper investigations to know whether any significant changes in glandular secretion or other control functions accompany the directional change in nasal air flow.

Table 1

During day time	Principal flow through right
During night	...... do ..... left
After the two principal meals (for half an hour)	...... do ..... right

Apart from this, I would like to mention a point on which I beg to differ. The inference that the direction of air flow changes in our lying position mainly to prevent foreign particles from entering our respiratory system—pronounced particularly in the dusty background of our cave-dwelling ancestors, is unacceptable. Because the distance between the two nostrils (being hardly a few millimeters) cannot play an appreciable part in protecting our respiratory system. Moreover, had it meant for natural safety, the nasal air flow from the two nostrils would not differ between themselves in other postures. I hope this field will open up a new vista of research in the field of biomedical engineering.

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Calcutta-700032

Crocodiles

Sir, S. Mohapatra, Wild Life Conservation Officer, Orissa in his letter (*S.R.*, January, 1977) has sought scientific reasons for occurrence of Gharial (*Gavialis gangeticus*) in the river Mahanadi separated by land over hundreds of kilometers from the North Indian rivers and its total absence in Godavari, Krishna and Cauveri rivers in South India. The main factor influencing the occurrence of the gharial is the depth of water of a river in summer. Usually gharials are found where the depth is 9.14m. The river Mahanadi has such depths, whereas the Godavari, Krishna and Cauveri in S. India are not that deep in summer except in the region of Papikondalu of Godavari river, near Bhadrachalam. It is probable that there may have been some gharials in Papikondalu area in the past. but there is no record. Unless the entire riverine system in south has been surveyed one should not conclude that there are gharials in South India.

At present, the wild gharials distributed in the world are as follows : North Indian rivers—102 adults; Mahanadi 4 adults; the rivers in Nepal have 51 adults : and all rivers in Pakistan have about 20 adult gharials. Probably they are extinct in Bangladesh, Bhutan and Burma. The extinction of the gharials is due to extensive hunting for its valuable skin. Each inch of the skin around the belly costs about Rs. 40/- in European markets.

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Bhubaneswar-751004

Versatile silicones

Sir, **The versatile silicones** by Gokulananda Mahapatra (*S.R.*, Dec. 1976) was interesting as well as informative. However, in addition to the numerous applications mentioned therein, a line about the contribution of silicones to vacuum technology would not be out of place. Silicone oils have exceptional chemical stability both at a high temperature and in contact with most gases and vapours, have low volatility and backstreaming, and extremely low vapour pressure ($\sim 2 \times 10^{-10}$ torr at 20°C for DC 705). The use of these oils, therefore, leads to the possibility of producing ultra high vacua in oil diffusion-pumped chambers without the necessity for a liquid nitrogen trap.

Pradeep Mohan
Physical Res. Lab.
Navrangpura
Ahmedabad-380009

Plants for population control

Sir, I read with interest the note **Plants for population control** under Science Spectrum (*S.R.*, Jan. 1977) in which the author has described some plants useful as antifertility/abortive agents under two heads - indirect utilisation and direct utilisation. I would like to refer, for the benefit of our readers, to a very comprehensive and excellent review article *Potential Value of Plants as Sources of New Antifertility agents* part I and II by Norman R. Farnsworth *et al.* in the *Journal of Pharmaceutical Sciences* (U. S. A.), April and May 1976 issues (Vol. 64 No. 4, pp. 536-589 and No. 5, pp. 717-745). There are 1675 references to the world scientific literature on the topic.

The need for effective agents for population control has been felt by almost all the nations of the world, more so by the developing countries, where the rate of growth is indeed alarming and unless checked will lead to acute shortage of food, clothing and shelter—the three basic requirements of human existence—and serious ill, health and biosocial problems. A breakthrough has to be made in the shortest period possible. In a vast country like India with an enormous wealth of medicinal plants, there is a great scope for discovering potential antifertility agents at low cost which most from our low-income group can afford. Considerable research efforts are being made by different organisations as mentioned in the note.

While recommending a drug for population control, we have to make a more prudent choice in antifertility/contraceptive agents rather than abortifacients, since the use of the latter will bring down the health of the mother in repeated pregnancies and abortions, particularly in our country where the general health of the common woman is not so good.

S. Sankara Subramanian
Professor of Chemistry
Jawaharlal Institute of Post-Graduate Medical Edn. & Research
Pondicherry-605006

Filariasis—its cause and control

Sir, Thank you very much for publishing a comprehensive article **Filariasis—its cause and control**(*S.R.*, Dec. 1976). We would appreciate if the author explains the term 'autocidal biological agent'.

Miss Rekha Mehera
Asansole (*W. B.*)

Autocidal biological control agent is an agent (may be a plant or an animal) which, when present in a particular environment, becomes hostile to the propagation of its own kind. Such agents are now widely used in genetic control experiments to eradicate the population of harmful insects, particularly different mosquito vectors responsible for the transmission of malaria and filaria in different parts of the globe.

Samar Chakrabarti
Department of Zoology
Hooghly Mohsin Govt. College
Chinsurah, West Bengal

Sir, I congratulate you on publishing the article **Filariasis—its causes and control** by Samar Chakrabarti (*S. R.*, Dec. 1976). Please clarify the term 'autocidal biological agent' used in the article and let me know why sterile female technique is not used to eliminate the mosquito vector as a control measure of filariasis.

Nandini Panigrahi
Cuttak, Orissa

Chlorine tablets

Sir, I wish to extend my thanks for the article **Chlorine tablets for drinking water purification** published in *S.R.*, January 1977. The National Environmental Engineering Research Institute, Nagpur has virtually solved the problem of the purification of drinking water in villages by developing a process for manufacture of chlorine tablets.

Satya Prakash Sinha
Pandeytola, Aliganj
Lucknow

Sir, I read the article **Plants for population control** by Renupada Nandi (*S. R.*, Jan. 1977) with great interest. The author has cited the botanical names of the abortive/contraceptive medicinal plants along with their Bengali names. I would like to mention the Hindi names of some of these plants so that the Hindi speaking readers may understand the article as botanical names are not commonly known. It will also help them in the collection of the plants from their local areas. The names are as follows : (1) *Abrus precatorius* (Hindi : Mulayti, Ratti, Chirmithi, Ghumchi.); (2) *Peganum harmala* (Hindi : Harmal); (3) *Anona squamosa* (Hindi: Sharifa, Sitaphal); (4) *Semecarpus anacardium* (Hindi : Bhilawa); (5) *Ruta graveolens* (Hindi : Somlata.), and (6) *Moringa oleifera* (Hindi: Sonjana).

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Department of Botany
Hindu College
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SHANTI SWARUP BHATNAGAR PRIZE FOR SCIENCE & TECHNOLOGY–1976

THE Council of Scientific & Industrial Research awards each year five or more prizes each of value of Rs. 10,000 for notable and outstanding research, applied or fundamental, in the following disciplines : (i) Physical sciences; (ii) Chemical sciences ; (iii) Biological sciences ; (iv) Engineering sciences : (v) Medical sciences ; (vi) Mathematical sciences ; and (vii) other sciences. The prizes are given in the memory of Dr. Shanti Swarup Bhatnagar, the founder director of the Council.

Nominations are invited for the Shanti Swarup Bhatnagar Prizes for Science and Technology for the year 1976. Any citizen of India below the age of 45 years as on 31st December 1975, and who has made conspicuously important contributions to fundamental/applied sciences in the particular field of his endeavour by his work done in India during the past five years preceding the year of the Prize, is eligible for nomination.

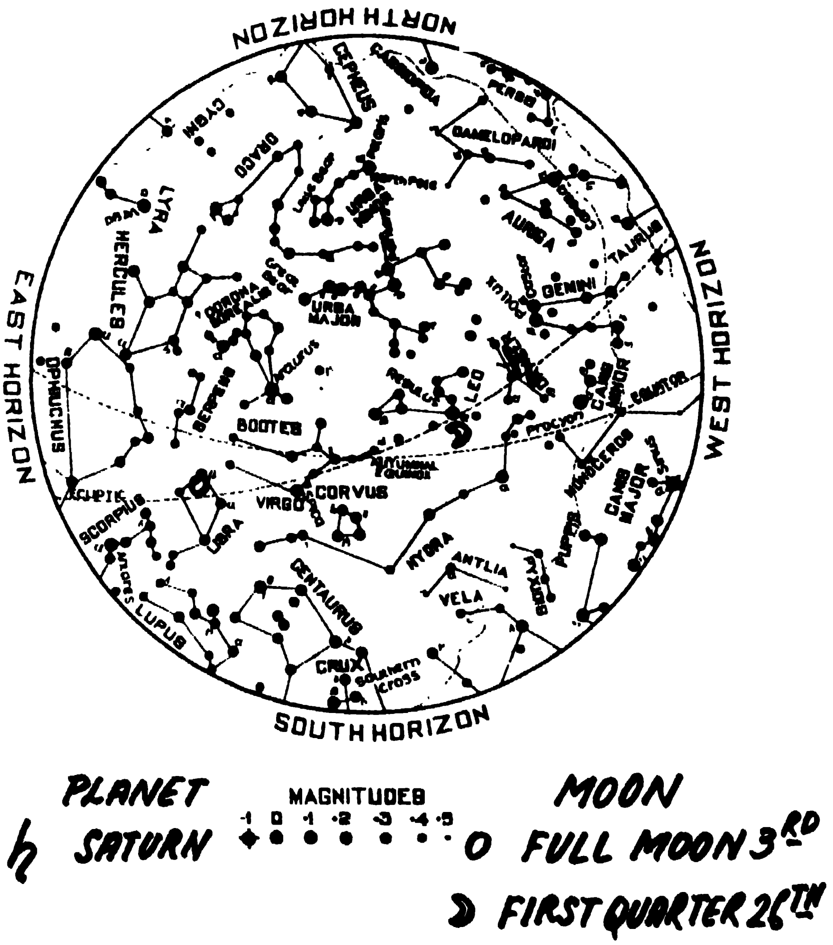
Nominations can be made amongst others by Vice-Chancellors of Universities/Deans of Science, Engineering including Technology and Medical faculties, Director of IITs, Deans of faculties and institutions deemed to be of University status and Head or Director-General of major R&D organisations such as DRDO, ICAR, ICMR, Space Communication, BARC, TIFR and the Directors of CSIR Laboratories. University Faculties and IITs should recommend persons working in their institutions only and route it through their respective Vice-Chancellors or Directors. The Directors of CSIR Laboratories can nominate a candidate in the discipline of their interest, irrespective of whether they are working in CSIR laboratories or outside.

Each such nomination shall be accompanied by detailed statement of work and attainments of the nominee and a critical assessment report (not more than 500 words) bringing out the importance of the significant research and development contributions of the nominee made during 5 years preceding the year of Prize.

The last date for receiving the nominations for the prize is 15 May, 1977. Nominations should be sent in sealed cover, marked 'Confidential' to the Head, Extra Mural Research, CSIR, Rafi Marg, New Delhi-110001.

Planets and their positions

MAY 1977



The moon

Full moon occurs on 3rd at 6-33 p.m. and New moon on 18th at 8-21 a.m. I.S.T. The moon passes about one degree north of Venus and about two degrees north of Mars on 14th, two degrees north of Mercury on 16th, about three degrees south of Jupiter on 19th and six degrees south of Saturn on 24th. The lunar crescent becomes first visible after the new moon day in the evening of 19th.

The moon is at perigee or nearest to the earth on 4th and at apogee or farthest from it on 18th.

The planets

Mercury (Budha) is too near the sun to be visible almost during the first half of the month. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It becomes direct on 14th and is at the greatest western elongation of about 25 degrees from the sun on 28th. It is in Aries (*Mesha*). Its visual magnitude varies from +1.9 to +0.6.

Venus (Sukra), a morning star, rises about two hours before sunrise during the month. It attains the greatest brilliancy on 12th and passes about a degree north of Mars at about local midnight of 13th. It moves from Pisces (*Mina*) to Aries (*Mesha*). Its visual magnitude is about —4.2.

Mars (Mangala), visible in the morning sky, rises about two hours before sunrise during the month. It moves from Pisces (*Mina*) to Aries (*Mesha*). Its visual magnitude is about + 1.3.

Jupiter (Brihaspati), an evening star, sets about an hour after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It passes about five degrees north of the star Aldebaran (*Rohini*) in the evening of 20th. It is in Taurus (*Vrisha*). Its visual magnitude is about —1.5.

Saturn (Sani), visible in the evening sky, sets at about local midnight during the first half of the month. It is in quadrature with the sun on 1st. During the second half of the month it sets about an hour before local midnight. It is in Cancer (*Karkata*). Its visual magnitude is about +0.6.

(*Source*: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N', New Alipore; Calcutta-53)

fingerprints–
A CLUE TO DISEASES

R.K. SARAN

Do lines on human palm indicate disease ?

DERMATOGLYPHICS, i. e., study of finger, palm and sole prints has been a subject of human interest since primitive times when man used to hunt for his food with the help of animal's footprints. Through ages palmists have predicted future by reading lines on human palm.

Scientific interest in this field is also very old. It dates back to 17th century when scientific workers like Dr. Nehemiah Grew, Fellow of the College of Physicians and Surgeons of the Royal Society, England in 1684 and Professor Marcello Malphigii, Professor of Anatomy at the University of Bologna, Italy in 1686 described the morphology of various parts of the palm. Other pioneers in this field have been Johannes Evangelist Purkinje who in 1823 submitted a thesis at the University of Breslau for a doctor of medicine degree describing fingerprint types and classifying them in nine major groups. Dr. Henry Faulds, an Englishman, working at the Tsukiji Hospital, Tokyo, around 1858 collected the fingerprints of Japanese and other nationalities and compared their ethnological differences. He also gave the valuable suggestion of identifying a criminal by his fingerprints left at the scene of crime. Later on further work by the anatomists, physical anthropologists and workers in the field of human genetics revealed the variations in pattern distribution on the basis of sex, race and ethnic background.

Medical interest in this subject is recent, although the notion that distinctive dermal patterns might be associated with disease is not new. It was stimulated when Prof. Harold Cummins, Professor of Anatomy, Tulane University in 1936 described the peculiar and specific dermatoglyphics of Mongoloid patients. Later in 1959, Mongolism was discovered to be associated with chromosomal aberration. Beside, Drs. Klaus Patau, Irene A. Uchida and David W. Smith of Medical School, University of Wisconsin, Madison, found *D* and *E* trisomy syndromes associated with unusual dermatoglyphics.

These discoveries led many workers to the study of dermatoglyphics of persons suffering from diseases due to chromosomal aberrations to see if their dermal configuration was any different from those of the normal individuals.

A large number of diseases, both congenital and hereditary, are being investigated for dermatoglyphic indications.

To appreciate the significance of dermatoglyphics, which now includes the study of flexion creases and other secondary folds also, some basic ideas of the patterns found on fingertips, palms and soles and the terminology used in this science will be helpful.

Fingers

Patterns. Patterns found on fingertips are broadly classified into arches, loops and whorls. In arches, ridges run parallel to each other without backward recurvature, while in loop ridges enter and end on the same side forming a hair-pin-like pattern. If

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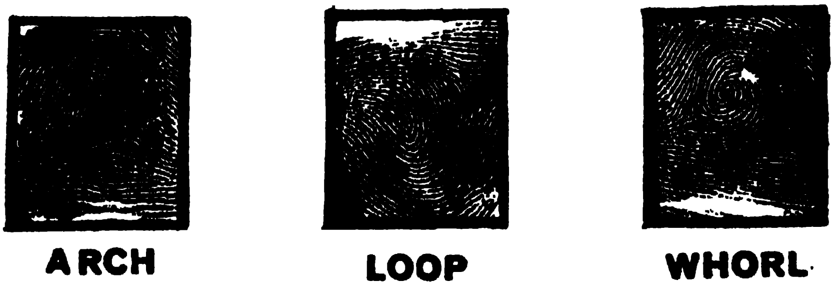

Fig. 1. The three main types of pattern found on the fingertips

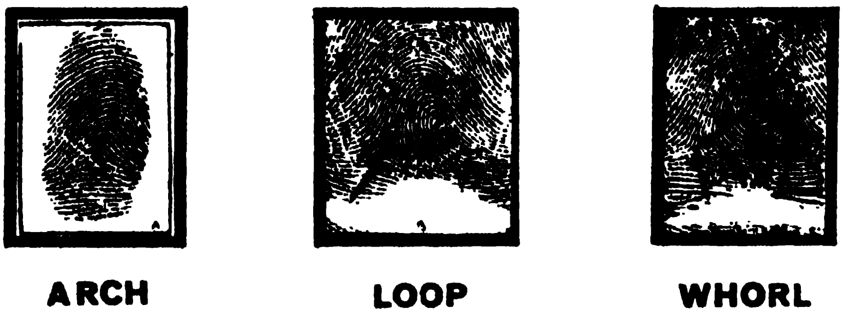

Fig. 2. Position of the triradius in a loop and whorl (marked by arrow). An arch has no triradius. The number of ridges between the triradius and the core, when joined by a straight line, constitute the ridge count of the pattern

they open towards the little finger side, they are called ulnar loops, and if they open towards the thumb they are called radial loops. A whorl is a pattern formed by concentric or spiralling ridges (Fig. 1).

Triradius. The meeting point of the three different fields of parallel ridges of the patterns is known as 'triradius' which is the main landmark for classification of prints. An arch has no triradius, loop has one at the closed end of the pattern. A whorl has two triradii, one on each side of the pattern (Fig. 2).

Ridge count. Ridge count is the number of ridges between the triradius and the core of the pattern. Core is the central point of the pattern. Total ridge count, which is the total score of all ten fingers, has been found to be genetically controlled (Fig. 2).

Palm

The main areas of the palm are the thenar, i.e., the mound below the thumb ; the hypothenar, i.e., parallel mound on the ulnar side of the palm and interdigital areas. These areas may or may not have patterns.

Each finger, except the thumb, has at its base one triradius which is designated as *a*, *b*, *c* and *d*, depending upon the finger. The fifth triradius known as 'axial triradius' and designated as *t* is towards the wrist crease side at or near the axis of the palm. Position of this triradius is important for dermatoglyphic analysis of the palm as it has been found to be displaced in many diseases (*Cover*).

Main lines. Main lines are the ones that are outlined by tracing the proximal line upto its termination at the palmar border. Exit position of each main line has been assigned an arbitrary number by adding which the Main Line Index is calculated (*Cover*). This index is a pointer to the general direction of the ridge course.

Flexion creases. A simple inspection of the palm shows major thick deep lines on the palm and the interphalangeal joints of the finger. They are known as flexion creases and mark the position of firmer attachment of the palmar skin to the underlying structures. Of these, the major ones are the three creases found on the palm ; the palmist's 'line of life', 'line of heart' and the 'line of head'. Sometimes two of these, i.e., 'line of heart' and 'line of head' are found fused together. In that case, it is called a Simian line. Being rare, it is a significant finding (Fig. 4).

All fingers, except the thumb, have two flexion creases; a single flexion crease is rarely found except in patients of chromosome abberration.

Sole

The same basic patterns, arches, loops and whorls as observed in hand, are found on toes as well. The mound adjacent to the great toe is known as hallucal area (Fig. 5). The most common pattern in this area is a loop opening into I-interdigital interval ; whorls are next in frequency (Fig. 6) ; open fields and loop tibial are less common. Sometime, an S-shaped modification of the simple arch is found on the hallucal area. This is known as Arch S-fibular and is rarely found.

Parameters employed for the dermatoglyphic study of diseases are many but the important ones are :

1. Fingertip pattern types and their frequency on various fingers;
2. Incidence of patterns of palmar areas ;
3. Total ridge count;

4. Position of the axial triradius ;
5. *a t d* angle ;
6. Main line index;
7. Simian line; and
8. Patterns on toes and hallucal areas of the sole.

Pattern types and their frequency

Normally, of all patterns, ulnar loop is common on various fingertips. The incidence of radial loop, mainly found on index finger, is very low. Whorls are next to ulnar loop in occurrence and arches and the least commonly found patterns. Table 1 shows the distribution of various patterns on different fingers in normal subjects.

In patients of Holt-Oram syndrome as much as 80% patterns on fingertips were found to be whorls in a study. In Mongolism, there is a marked reduction in the frequency of whorls and a compensatory increase of ulnar loops. Likewise, radial loops are seen not infrequently on digits other than index finger in patients of congenital rubella and Holt-Oram syndrome.

Incidence and type of patterns on the palm

Types of patterns found on the palmar areas are comparable to those on fingers, i.e., they are arches, loops and whorls, but vestigeal patterns and open fields (no patterns) are also found. Just the presence or absence of a pattern in a palmar area may be significant. In normal subjects, patterns on the hypothenar, II-interdigital and III-interdigital areas of the right hand, and thenar/I-interdigital and IV-interdigital areas of the left hand are abundant.

More than normal incidence of patterns in hypothenar area is found in diseases like Mongolism, Turner's syndrome and pseudohypoparathyroidism, while in patients of phenylketonuria the incidence of patterns is decreased.

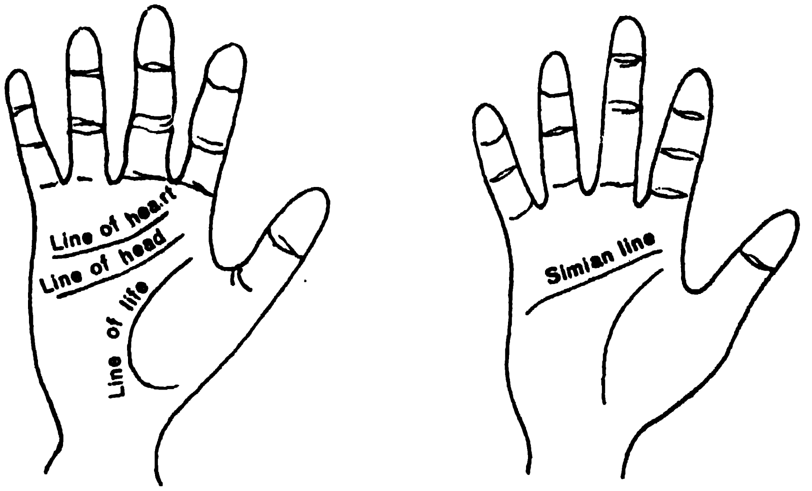

Fig. 4. Diagrammatic sketch of the hand showing normal flexion creases on the fingers and palm (*left*) and Simian line (*Right*)

Ridge count. Normal values of the ridge count, as per Penrose, L. S., *Nature* (London), 197, 1963, are Arch=0, Loop=12 and Whorl $><$ 19 and the total ridge count (score of all the ten fingers) : Male=145 and Female=127.

A higher total ridge count is found in diseases like Holt-Oram syndrome and Turner's syndrome (male), while in Klinefelter's syndrome the ridge count has been found to be significantly lower.

Position of the axial triradius. The axial triradius *t* is towards the wrist crease side in about 64% of the normal subjects (*Cover*), but in majority of patients of Mongolism, *D* trisomy, *E* trisomy, Cri du chat, Turner's syndrome, Turner's syndrome (Male), rubella syndrome, pseudohypoparathyroidism, dysautonomia and congenital heart disease it has been found to be distally placed, i.e., towards the finger-base side, and is known as distal axial triradius (Fig. 7).

a t d angle. The angle formed by joining the triradii *a*, *t* and *d* is known as *a t d* angle (*Cover*). According to a study by Dr. L. S. Penrose of Galton Laboratory, University College, London, it is 48° in normal, 66° in Turner's syndrome, 81° in Mongolism and 108° in *D* trisomy (Fig. 7). In another study by Drs. Darby and Hughes of Institute of Child Health, London, total *a t d* angle in patients of Cat eye syndrome was found to be 190°, in Mongolism 162° and in Patau's syndrome 216°.

Main line index. It is a pointer to the general direction of the ridge course on the palm and is calculated as explained before. The greater the number of main line index, the higher the tendency of the ridges to course horizontally.

Normally the palmar ridges slope towards the wrist crease side. However, in fanencephaly there is an increased incidence of transversality of ridges, while in Turner's syndrome the orientation of ridges is vertical.

Simian line. It is present in only 2% of the normal individuals, but in patients of Mongolism, Turner's syndrome and *D* and *E* trisomy it is found in abundance.

Patterns on toes and the hallucal area of the sole. Fibular loop is the most common pattern found on I, II and IV toe of normal subjects. Whorls are next to fibular loop in occurrence and are mostly found on III toe. Arches are common on V toe. In hallucal area of the sole, the most common pattern found in normal subjects is loop distal (Fig. 6).

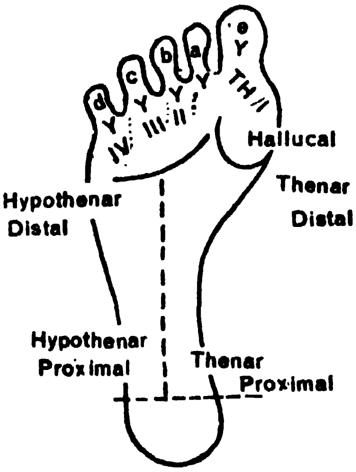

Fig. 5. Diagrammatic sketch of the sole showing various configurational areas (*Courtesy : Cummins and Midlo: Finger, Palm and Sole Prints, an Introduction to Dermatoglyphics*)

Table 1

Patterns	Thumb %	Index %	Middle %	Little %	Ring %
Arches	3.49	10.63	7.03	2.30	0.83
Ulnar loops	60.89	35.20	74.07	62.27	87.62
Radial loops	0.21	24.70	2.52	0.98	0.11
Whorls	35.41	29.47	16.37	34.44	11.41

Table 2

	Toe				
Patterns	I %	II %	III %	IV %	V %
Arches	11.8	8.7	4.8	20.9	51.1
Loops	80.4	72.5	37.5	60.6	48.9
Whorls	7.8	18.9	57.8	18.6	0.6

Table 3. Incidence of patterns on the hallucal area of the sole

Patterns	Frequency
Whorls	30.8%
Loop distal	48.5%
Loop tibial	7.3%
Openfield	12.2%
Others	1.5%

Tables 2 and 3 give the incidence of patterns on toes and hallucal area of the sole in normal subjects.

Dermatoglyphics of patients of Mongolism showed an incidence of 56.4% of arch tibial on the hallucal area of the sole, while in controls it was less than 1% in a study by Reed, T. E., *J. Pediat.*, Dec. 1970, Vol. 77. Patients of *D* trisomy show a rare pattern Arch S-fibular.

Besides Mongolism, other conditions in which distinctive dermal patterns have been well established are ; Turner's syndrome, Klinefelter's syndrome, congenital heart disease, schizophrenia, *D* and *E* trisomy, De Lange syndrome, ancencephaly, phenylketonuria, and neurofibromatosis as per Ruth Achs and Rita Harper, *Am. J. Obs. & Gynec.*, vol. 101, 1968.

A review of literature on the subject shows that other clinical entities in which dermatoglyphical studies are underway in various parts of the world are ; rheumatism, diabetes, leprosy, coeliac diseases, leukaemia, schizophrenia, childhood cirrhosis, Wilson's disease, sickle cell disease, cardiovascular diseases, rubella syndrome, and retinoblastoma, etc; to name only a few. Some social problems like juvenile delinquency, criminal behaviour and mental retardation are also being investigated for dermatoglyphical marker.

Nevertheless, dermatoglyphic data should be interpreted with caution. Dermatoglyphic marker of any disease is not an abnormal pattern; it is only a normal pattern found in abnormal frequency or at a place different from the normal. An abnormal pattern is rarely found. For example, Simian line, significant and characterstic finding in Mongolism and present in about 50% of patients is found in 2% of the normal population as well. Moreover, sex, race and ethnic background of the subjects should also be taken into consideration. This is important be-

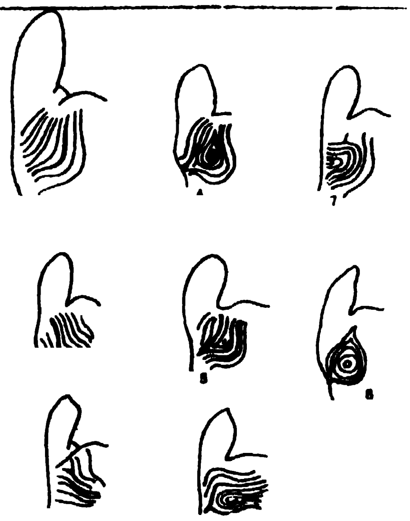

Fig. 6. Some of the main patterns found in the hallucal area of the sole: 1. Tibial arch, 2. Fibular arch, 3. Proximal arch, 4. Large distal loop, 5. Small distal loop 6. Fibular loop, 7. Tibial loop, 8. Whorl (Reed *et al.*, *J. paed.*, Dec. 1970, vol. 77)

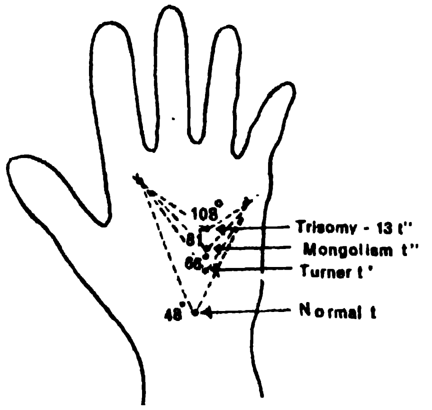

Fig. 7. **Position of the axial triradius *t* and the *a t d* angle in normal and in some of the diseases (Penrose, L.S., *Nature* (London), 197, 933, 1963)**

Table 4

Disease	Dermatoglyphic findings
Mongolism	Radial loops on 4th and 5th digit, ulnar loop on all digits, main line index above 10, distal axial triradii, increased incidence of hypothenar patterns, and Simian line, single flexion crease on 5th digit
Turner's syndrome	High ridge count of finger tip patterns, increased incidence of hypothenar patterns and Simian line, distal axial triradii, vertical orientation of ridges
Klinefelter's syndrome	Low ridge count of fingertip patterns, increased incidence of arches on fingertips
Congenital heart disease	Distal axial triradii

cause the incidence of various patterns differs in male and female and also in different ethnic groups. A similar finding in a heterogeneous test sample is more significant than in a homogeneous sample.

Still, the role of dermatoglyphics as a diagnostic tool is worth notice. It certainly helps in confirming a diagnostic impression even if it does not surely lead to diagnosis. As per Ruth Achs and Rita Harper. *Am. J. Obs. & Gyn.*, vol. 101, 1968 ;

"A distally placed axial triradius may be useful in altering a physician to the possibility of congenital heart disease in presence of heart murmur......"

Moreover such studies can be extended to many other diseases phenomen a like sensitiveness of some persons to drugs like penicillin, primaquine, pethidine and ATS. Patients of other types of allergies and asthma could be investigated for any significant dermatoglyphics marker. If a marker could be found, their possible predispositions to such illness can be known right from their birth. What is needed is more research in this branch of science.

Appendix

Anencephaly. Absence of brain, or of all but the basal ganglia and cerebellum in an individual.

Cat eye syndrome. A chromosomal disorder manifesting in fissure of the iris and other abnormalities.

Cri du chat. Disease of chromosome aberration manifested by mental retardation, failure to thrive and a characterstic "cat like cry".

D trisomy. Anomalies like cleft palate and polydactyly, etc; resulting due to an extra chromosome in D (13-15) group of chromosomes.

De Lange syndrome. A syndrome characterised by mental retardation, by shy eyebrows, low forehead, low set ears and other features.

Dysautonomia. A genetic disease with abnormal functioning of the autonomic, nervous system such as absence of tears, vomiting, sweating, emotional instability, frequent attacks of bronchial pneumonia and an intolerance for anaesthetics.

E trisomy. Chromosomal disorder; aberration in E (16-18) group of chromosomes, manifested in infants by deformities of hands, feet and malformations in the heart and in renal and skeletal systems.

Holt-Oram syndrome. A syndrome, named after the discoverers, consisting of defects in heart valves and abnormalities of the upper extremity, specially, thumb.

Klinefelter's syndrome. Caused by an extra X chromosome and manifested by breast hypertrophy, mental retardation, infertility and eunuchoidism in males.

Neurofibromatosis. A genetic disease mainly manifesting in the skin in the form of spots and nodules involving nerve roots.

Phenylketonuria. Inherited biochemical defect in the normal oxidation of phenylalanine to tyrosine due to genetic disorder.

Pseudohypoparathyroidism. Familial hereditary disease characterised by short stature, round face, shortness of fingers and unresponsiveness to parathyoid hormone.

Retinoblastoma. Retinal tumour exhibiting familial tendency.

Rubella syndrome. Caused by rubella virus infection in the embryo; German measles.

Sickle cell disease.A hereditary disease characterised by sickleshaped erythrocytes in the circulation.

(*Continued on page* 222)

From electrons to quarks, the history of particle is a story full of thrilling discoveries

HISTORY OF PARTICLE PHYSICS

VISVAPRIYA MUKHERJI

IN his Tarner Lectures at Cambridge in 1938 Sir Arthur Eddington, the physicist-philosopher, discussed his concept of elementarity and analysis, and expressed his belief that our "engrained form of thought" prompted us to represent all physical phenomena as an interaction of a multitude of "intrinsically alike structural units" and that "there is nothing in the external world which dictates this analysis into similar units, just as there is nothing in the irregular vibrations of white light which dictates our analysis of it into monochromatic wave trains. The dictation comes from our own way of thought which will not accept as final any other form of solution of the problem presented by sensory experience." We do not know whether this form of thought is native to Man or has been acquired by him through centuries of experience and observation. But this much is known that when scholars of distant antiquity such as Democritus of Greece and Kanada of India conceived of matter to be composed of basic, irreducible structural units (or atoms) moving randomly in the void, they depended on purely philosophical speculation without reference to any convincing empirical evidence. And when Gassendi, a French scholar of the 17th century, resurrected Democritean atomism in the face of the prevailing Aristotelean doctrine of matter being continuous and nondiscrete and when Dalton established (1808) a rational science of chemisty on the basis of atomism (or corpuscular description of matter), there was "nothing in the external world which dictated this analysis into similar units". The electron, which was the first "elementary" particle to be discovered towards the end of the last century, was not universally accepted as a discrete irreducible unit of matter. Some schools of scientific thought were averse to the idea of the atomicity of matter and favoured the description of all phenomena in terms of continuously distributed matter and continuously acting laws. However, experimental investigations of diverse phenomena like Brownian motion, cathode rays. positive rays, radioactivity, x-rays, photoelectricity, blackbody radiation, hydrogen spectrum tipped the scale in favour of the concept of the discreteness of matter, charge as well as energy. Within the first decade of this century the electron was generally accepted as an elementary building block of matter.

When in 1911 Rutherford proposed his planetary model of the atom, he boldly pictured the orbital particles as electrons, but the elementary units of the central positive kernel or nucleus were yet to be clearly defined and determined.

Since positively charged alpha particles were found to be emitted from radioactive substances, physicists were tempted to consider alpha particles, i.e., helium-atom nuclei, as a kind of basic building stones of atomic nuclei. In 1920 Rutherford gave the name proton to the hydrogen nucleus—the incomparably heavier positive counterpart of the electron. But physicists took some time to be convinced that the proton was a fundamental unit constituting not only the alpha particle or helium nucleus but also all other atomic nuclei. Jensen refers (Nobel Lecture, 1963) to a persistent warning from Schroedinger that one should not be tempted to look upon alpha particles as basic constituents of nuclei:

> **"During the late twenties he (Schroedinger) chided the participants in a Berlin seminar for their lack of imagination. In his impulsive manner he said, 'Just because you see alpha particles coming out of the nucleus, you should not necessarily conclude that inside they exist as such'.... The situation that very little insight into nuclear structure could be gained from this oldest nuclear phenomenon persisted for a long time".**

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It is worth mentioning here that as early as 1886 Crookes had predicted the existence of isotopes, and that in 1913 J. J. Thomson found the direct experimental evidence of the former's prediction by discovering two kinds of neon of atomic weight 20 and 22. Therefore, by 1913 it was conceptually necessary to explain why atoms of the same element (i.e., same nuclear charge) varied in weight. In April 1920 Harkins published a proposal that isotopy could be explained by imagining the existence, in the nucleus, of extra protons with closely packed neutralizing electrons. In June 1920 Rutherford also said in the Bakerian Lecture at the Royal Society of London :

> "Under some conditions.... it may be possible for an electron to combine.... closely with the hydrogen nucleus, forming a kind of *neutral doublet*. Such an atom would have very novel properties. Its external field would be practically zero, except very close to the nucleus, and in consequence it should be able to move freely through matter. Its presence would probably be difficult to detect by the spectroscope.... On the other hand, it should enter readily the structure of atoms and may unite with the nucleus". (Italics mine)

This was the prediction of the *neutron*, which was discovered more than a decade later. But Rutherford's neutral doublet evidently meant a compound particle and not an elementary one. Anyhow, in the subsequent years the possible existence of an electrically neutral particle was sought, and in 1932 Chadwick discovered the neutron. At that time Chadwick hesitantly suggested that the neutron might be "elementary". One thing had to be admitted that the initial assumption that the neutron was a proton plus an electron did not agree with empirical evidence, whereas the hypothesis that the neutron was an elementary constituent of atomic nuclei explained the empirical data very satisfactorily.

Soon, however, the neutron came to be universally accepted as an elementary particle, and one could consider that protons and neutrons were the fundamental structural units within the atomic nucleus. The initial conceptual uneasiness about the neutron's theoretical characterization was dispelled when Heisenberg and subsequently Cassen and Condon placed the proton and neutron on an equal footing (by postulating that they are two manifestations of one particle, the so-called "heavy particle" or nucleon) in terms of a non-visualizable quantum-physical quantity, the isotopic spin which assumes the value $+1$ for the "proton state" and -1 for the "neutron state" of the nucleon. Thus, this conceptual economy was an important step towards classificatory unification of "elementary" particles. It should be mentioned here that till then physicists had been dealing with the stable particles, the proton and electron. But with the addition of the unstable neutron, which decayed into a proton and an electron, physicists got accustomed to the idea that an "elementary" particle had a finite lifetime and that it could change into other "elementary" particles.

With increasing sophistication of quantum theory, particle physics had been already moving away from visualizable representations towards abstract and formal concepts with no analogues in classical physics. For example, the descrpition that the "electron spins or rotates" is just a convenient visualization of the electron's behaviour which cannot really be described classically. And the subsequent history of particle physics is one of invoking a host of abstract non-classical quantities intended for establishing unified classification schemes of formal simplicity in the disconcerting manifoldness of "elementary" particles.

Since scientists aim at reaching intrinsically alike structural units of matter, it is natural that there was some resistance to the introduction of the neutron as a new "elementary" unit when already two accepted elementary particles—the proton and electron—could apparently explain the existence of different chemical elements and their isotopes. However, theorists had to accord elementarity to the neutron in order to account for all observed nuclear phenomena satisfactorily.

Before the discovery of the neutron, two other problems in particle physics baffled the theorists. These belied their unsophisticated hope of setting up a tidy classification scheme with a very limited number (if not "intrinsically alike") of structural units.

In 1930 Dirac put forward his well-known electron theory which required that there should symmetrically exist an exact positive counterpart (antiparticle) of the electron.

Dirac tried to identify the predicted antiparticle with the known particle, proton, but he felt unhappy about "the difficulty of the large mass difference". According to him, the mass of a proton should be the same as the mass of an electron. At that time he did not suspect that the proton was not the predicted antielectron and that the theory needed to modification. The actual need was to experimentally search for a new particle which would exhibit the same mass as the electron but an opposite charge. However, before Dirac's theory could be taken seriously, Anderson discovered (1932) in cosmic rays the real antielectron (positron) uninfluenced by Dirac's prediction. Dirac's theory was taken seriously only after Anderson's discovery. Once the theory proved convincing, this diversification of elementary particles did not disconcert the theorists; rather, they considered it to be an indication of a fundamental symmetry of Nature that manifests itself in two charge conjugates for every particle. Evidently, it was theoretically expected that antiprotons or negative protons too might be detected in cosmic rays, since all particles could exists in an antistate. As late as 1954 the antiproton could not be decisively detected in cosmic rays, but that very year the high-energy particle accelerator "Bevatron" which had been purposely designed to produce antiprotons came into operation, and the next year Segre and others did discover the antiproton. Just as earlier there had been voices of dissent after the introduction of any new elementary particle, the existence of the antiproton too was not unreservedly believed in (before its discovery) by some dissenters as an obvious consequence of Dirac's theory. Alvarez said (Nobel Lecture, 1968) :

> "In support of the non-obvious nature of the Segre group's discovery of the antiproton I need only recall that one of the most distinguished high-energy physicists I know, who didn't believe that antiprotons could be produced, was obliged to settle a 500-dollar bet with a colleague who held the now universally accepted belief that all particles can exist in an antistate".

In contrast with such a scepticism about the antiproton, Dirac's bold imagination of the possible existence of an "antiworld" composed of positrons and antiprotons is really remarkable. This he expressed as early as 1933 in his Nobel Lecture.

Interestingly, shortly after the discovery of the positron it was experimentally established that, as required by theory , an energy radiation like gamma-ray can change into matter represented by an electron-positron twin (i.e., particle-antiparticle pair) and that if a slow electron and positron meet, they would be annihilated as material particles causing the production of an energy radiation.

Thus the Dirac theory's conceptual expectation prompted physicists to accord elementarity to all observed as well as yet unobserved antiparticles, although their existence seemingly belied the earlier naive hope of framing a unified classification scheme with a handful of "elementary" particles. The second problem referred to above was this : This experimental data concerning beta-ray activity, i.e., emission of electrons from radioactive substances, needed a satisfactory theoretical explanation. The data seemed to violate the well-established law of energy conservation! In fact, of all persons, Bohr suggested that the energy of some emitted electrons or beta-rays was conserved, whereas for some emissions the law of conservation was violated; however, the total effect for many such emissions was a "statistical conservation of energy". This fantasy was not taken seriously by physicists. Pauli "hit upon a desperate remedy to save the law of conservation of energy". In December 1930 he hypothesized the existence of a chargeless particle of evanescent mass "which exists in the nucleus" and is emitted "with each electron... in such a way that the sum of the energies of this particle and electron is constant". This idea of an almost massless neutral particle was received with great scepticism. But Fermi took Pauli's hypothesis seriously, named the elusive particle neutrino and built up in 1934 his convincing theory of beta-emission in terms of the so-called "electron-neutrino field" in analogy with the theory of emission of light quanta or electro-magnetic field by an excited atom. He, however, did away with Pauli's assumption that the neutrino "existed in the nucleus" and conceived of the mechanism of concomitant creation of an electron and a neutrino when the nucleon passes from the proton state to the neutron state or vice versa.

No sooner had the electron-neutrino theory been proposed by Fermi than the notion of an "antineutrino" was suggested. And immediately (1934) Bethe used the Fermi theory to show theoretically that a free antineutrino acting directly upon a proton would yield a neutron and a positron. But this prediction could not be tested with the techniques available at that time. About 20 years later Cowan and Reines discovered the antinuetrino (supposed to be oozing out from a nuclear reactor) by experimentally substantaiting its action upon the proton, as predicted by Bethe. Thus the elusive particle together with its antiparticle, which had to be introduced to save the law of energy conservation, joined the proliferating group of "elementary" particles.

The moment Fermi's theory offered in 1934 a convincing description of beta-decay, Heisenberg was the first to suggest that the force, which held the protons and neutrons together inside the nucleus, might be due to the shuttling of an electron-neutrino pair between two nucleons. And this explanation of the nuclear force was seriously pursued. But the calculated force was found to be about 10^{14} times weaker than the empirical value. So they had to grope for an alternative mechanism for the nuclear force. This pointed to the need of introducing a new particle-conveyer of the nuclear force. In 1935 the Japanese physicist, Yukawa boldly postulated the existence of a new particle (christened later by Anderson as mestron and then by Bhabha as meson) of mass about 200 times the electrons mass which would satisfactorily account for the nuclear force. As usual there was an initial reluctance among theorists to accept a new particle. In early 1937 Bohr visited Japan when Yukawa talked to him about the meson theory, but Bohr asked "Why do you want to create such a new particle?" However, soon Anderson, who had discovered the positron, announced the detection of a new charged particle of mass about 200 times that of the electron in cosmic rays completely unaware of Yukawa's prediction. Physicists now considered this to be identical with the predicted meson and took Yukawa's theory seriously. However, for the whole decade subsequent to this discovery they felt baffled by the disagreement of some properties of the observed meson with the corresponding properties of the predicted meson, and the theorists attempted to reconcile the theory with the observed properties of the cosmicray meson till 1946 when Marshak in the USA and Sakata in Japan independently felt it necessary to assume that the observed meson was not the Yukawa meson but was its decay product. The theory based on nuclear data demanded that the Yukawa meson must interact "strongly" with the nucleon, but an Italian group of experimentalists, Conversi *et. al.*, decisively showed (1946) that the cosmic ray meson interacted "weakly" with the nucleon, just as the electron and neutrino did in the case of beta emission.

This meant that the predicted (Yukawa) meson was yet to be discovered. In 1947 Powell discovered the Yukawa meson which he named the *pi*-meson or pion, and its decay product was named the *mu*-meson or muon. The latter was identified with the cosmic ray meson that had baffled the theorists till then. So two more particles were added to the list of "elementary" particles. It should be mentioned here that as early as 1938 Kemmer postulated the existence of a neutral meson which had to be invoked for explaining the nuclear bond between two protons or two neutrons, just as Yukawa had to introduce a charged meson for describing the bond between a proton and a neutron. As usual there were dissenters who felt reluctant to recognize the existence of "unobserved neutral mesons" which "is not indispensable to a theory of nuclear forces" (Marshak, 1940). But with the discovery of the pion the theorists got over their reluctance to recognize "unobserved" particles, especially those needed to theoretically account for all observed atomic and nuclear phenomena satisfactorily. So the neutral pion was searched for and discovered in 1950. Thus the pion family was filled out with a positive, a negative and a neutral particle. The study of the charged pions became easier, because these were found to be copiously produced (1948) in the 184-inch cyclotron; and the 300-MeV synchrotron could be used by the experimentalists for studying the neutral pion.

The elementary particles, electron, neutrino, pion, proton, neutron (with corresponding antistates) and neutral particles as well as the light quantum (photon) had to be introduced for explaining all atomic and nuclear phenomena. But the muon does not belong to that category. It happens to exist but is not pressingly needed for interpreting ordinary atomic and nuclear phenomena. Thus it appears to be a "superfluous" particle from the viewpoint of ordinary atomic and nuclear physics. However, it has been gradually felt since 1949 that the muon and electron not only belong to one class, they may even be intrinsically the same particle, the former being a "higher state" of the latter; nevertheless, the great mass difference between them still baffles the theorists.

In the wake of the discovery of the pion came a deluge of "superfluous" particles which greatly disconcerted the theorists. From 1947 onwards, started arriving the unstable particles: V-, tau-, theta-, sigma- and xi-particle and a host of other particles, all of which proved to be "strongly interacting" among themselves. Thus strongly interacting particles began to proliferate, whereas the "weakly interacting" particles remained limited in number.

Another baffling problem was the well-known "tau-theta puzzle". Until 1956 the physical quantity parity (which may be crudely understood as "mirror symmetry") was believed to be conserved as rigorously and universally as mass, charge and energy. The two particles "tau" and' 'theta" seemed to be dentical particles, because they exhibited identical mass and lifetime; but the parity-conservation law appeared to break down, as inferred from the observation that tau decayed into 3 pions and theta into 2 pions. Why did two exactly alike particles differ in one respect? Two alternatives presented themselves to Lee and Yang: either, to "save" the "sacred" principle of parity conservation at the same time admitting that two particles having the same mass and lifetime were "distinct" particles, or, to recognize that tau and theta were the same particle but parity was not conserved in the case of their decay, i.e., in the case of weak interactions. The second alternative, said Yang (Nobel Lecture 1957), "did not appeal to us. Rather we were, so to speak, driven to it through frustration with various other efforts at understanding the theta-tau puzzle that had been made". Experiments confirmed the selective validity of the parity-conservation law for strong and electromagnetic interactions and its violation for weak interactions. Tau and theta could now be thought of as one and the same particle, K-meson.

With the establishment of such selective conservation laws, the theorists renounced the hope of framing a comprehensive unified scheme embracing both the heavier particles or hadrons like the pion, K-meson, nucleon, lambda, sigma, xⁱ, etc. (SI-particles) and the light particles or leptons such as the neutrino, electron and muon (WI-particles). By mid-1950's they became reconciled to grouping the hadrons and leptons under separate schemes governed by different sets of laws.

Consistent with the pragmatic generalization that most of the conservation laws governing the hadrons are of little meaning for the leptons, Sakata proposed (1956) his "unified" classification for the multiplicity of hadrons in terms of only three "truly elementary" hadrons: proton, neutron and lambda. This hypothesis was followed up by Ne' eman and Gell-Mann (1961, 1962) who proposed the so-called "Eightfold" classification scheme in terms of an elegant symmetry between Sakata's "elementaries" and two more hadrons, the sigma and xi. Gell-Mann next predicted the existence of so-called quarks and antiquarks, i.e., fractional electric charges ($\frac{2}{3}$ and $\frac{1}{3}$ of the electron's or proton's charge) which perhaps might be the "ultimate" constituents of the different hadrons. Ehrenhaft's futile search (1922) for "subelectrons" or particles having fractional electronic charge was a naive anticipation of the recently postulated quarks, which are being searched for in cosmic rays but have not yet been detected.

However impressive may have been the attempts to understand the plethora of particles and antiparticles (82 by 1964) in terms of a small number of truly fundamental particles, "one nevertheless feels", wrote R. D. Hill (1964), "that the basic theoretical understanding of where the many particles fit into our broad comprehension of matter and forces is still awaiting solution". There has been, since 1964, no essential change in that dead-end situation. We may recall that the introduction of each new particle like neutron, neutrino and meson was greeted with sceptical remarks, but the strong theoretical expectation of their existence and subsequent experimental verification made them acceptable to the dissenting theorists. But the muon and the first "strange" particles were discovered more or less accidentally before physicists had theoretically anticipated their existence and properties. Such particles, said H. Primakoff in 1964, "no doubt appear 'superfluous' from the point of view of ordinary atomic and nuclear physics only because we lack a deeper understanding of their role.". The new "superfluous" particles discovered since 1947 are perhaps closing the ring of discoveries, and their increasing multiplicity or antithesis will perhaps lead to a convincing synthesis.

It is necessary to mention here that modern physicists have directed their attention also to the problem of determining the "inner structure" of the "elementary" particles which are treated as structureless geometrical points. In the late 1950's Robert Hofstadter experimentally indicated that the proton and neutron (the nucleon, in general) had internal structure, for which he was awarded the Nobel Prize in 1961. Let us conclude our review with what he said in the Nobel Lecture :

> **"The proton and neutron, which were once thought to be elementary particles, are now seen to be highly complex bodies. It is almost certain that physicists will subsequently investigate the constituent parts of the proton and neutron... What will happen from that point on? My personal conviction is that the search for ever smaller and ever-more-fundamental particles will go on as long as Man retains the curiosity he has always demonstrated."**

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FINGERPRINTS *(Continued from page 217)*

Turner's syndrome A chromosomal disorder often associated with the absence of Y chromosome and manifested by dwarfism, webbed neck, amenorrhea and sexual infantilism in females.

Turner's syndrome (Male). Turner's syndrome when manfested in males.

Wilson's disease. Hereditary disease characterised by increased deposition of Copper in tissues.

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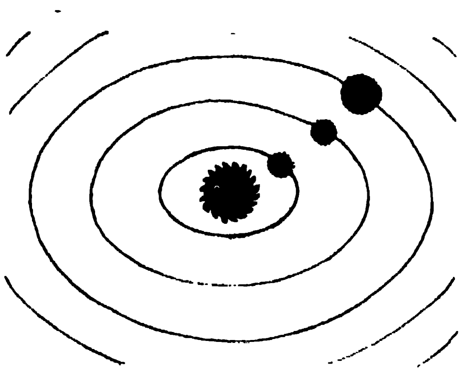

HOW SUN AFFECTS THE EARTH

RAMA KOTESWARAM
D.N. MADHUSUDHANA RAO

With the increased knowledge of atmospheric and space physics, there has recently been a renewed interest among scientists in sun-weather relations

"If the Sun in red doth set,
the next day surely will be wet;
If the Sun doth set in grey,
the next day will be a rainy day.."

MAN has searched in heavens for the causes of events taking place on earth since the time he began to think. Within the past few centuries he has been changing the face of the land, the balance of the living things and the composition of the atmosphere. He has been till today unable to conquer the atmosphere. The various moods of the atmosphere such as the vagaries of weather intrigue him, since he is dependent on it and his very existence is threatened. With the realisation that sun is the potential source of life on earth, he naturally tries to associate the events on earth to some phenomenon on the sun.

That there is a relationship between solar activity, weather and climate is a point that has been debated scientifically for more than a century. Although there is fragmentary evidence in support of an extra-terrestrial influence, scientists were doubtful in accepting the influence of solar activity. Their main criticism was that much of the extensive emperical and statistical evidence presented has been complex, imprecise, inconclusive and even contradictory. Further, no theory or plausible mechanism is given to explain physically how solar activity can affect meteorological parameters.

However, in recent times, with increased knowledge of the atmospheric and space physics and from direct measurements of solar activity parameters, there has been a renewed interest among scientists on solar-weather relations.

The cyclic (11 years or 22 years double cycle) variation of sunspots has long been considered as a reliable measure of solar activity. It has been observed that severe droughts in high plains in central United States during the past 150 years recurred with a periodicity of about 20 to 22 years and with a constant phase relationship to the alternate minima of a solar activity (sunspot) cycle. Also about 43% of world's major famines which occurred since 1700 A. D., were in sunspot minimum periods or the year preceeding the minimum years. In the period 1866-1963, of the ten sunspot minimum years eight coincided with famine occurrences in which at least 26 million people died. It is also of interest to note that 75%-80% of all known glacier advance events and other indications of cold climate in late glacial and post-glacial periods occurred during intervals of low sunspot activity, and a similar percentage of glacier recession and warm climate occurred during high solar activity.

An interesting climatic response to solar activity is found in rainfall

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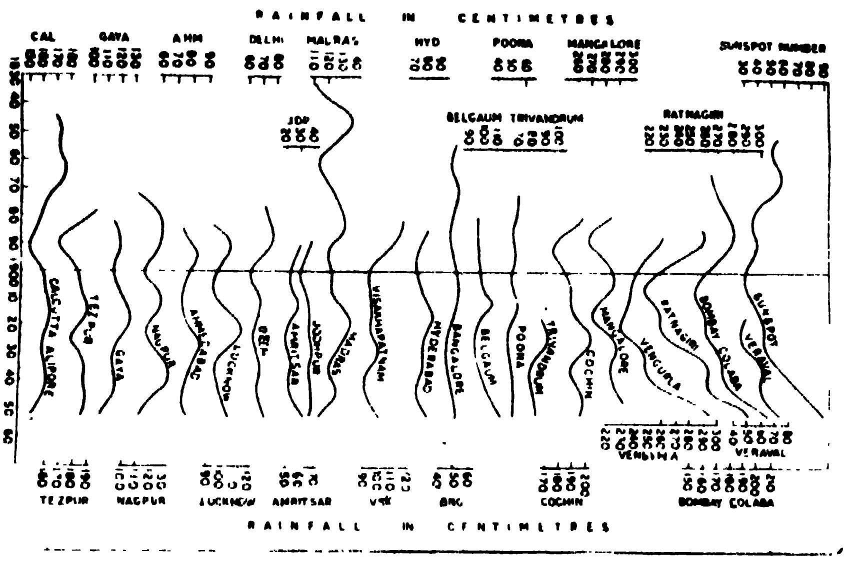

Fig. 1. Annual rainfall (for Indian stations) variation with solar activity (*After* Prof. P. Koteswaram)

data. The rainfall at many stations in the world is found to be affected by solar activity. Prof. P. Koteswaram and his colleagues showed that the monsoon rainfall along the west coast of India north of Mangalore steadily rose from 1900 to 1957 along with the corresponding increase in sunspot activity and started decreasing thereafter (Fig. 1). However, at other inland stations no long term trends and periodicities of rainfall are describable. Rainfall at Trivandrum and Cochin and a number of other places seem to respond to 11 year sunspot cycle. Extensive work carried out by J. W. King (England) and many others conclusively proved that the rainfall at various stations in northern and southern hemispheres has correlation with sunspot cycle (either 11 year or 22 year). It has been statistically established that there is 'definite significant' correlation (in fact, correlation coefficients upto 0.8-0.9 were obtained) between sunspot number and frequency of occurrence of thunderstorms. Thunderstorms occur in maximum sunspot activity periods. One scientist humorously put it thus "since it is inconceivable that thunderstorms cause sunspots, it is reasonable to assume that sunspots or some other phenomena associated with sunspots cause thunderstorms".

Scientists are not satisfied with the mere correlations and statistical evidences relating climatic conditions —cyclones, famines, etc., with solar cycle. They want some definitive proof linking solar(–geophysical) and meteorological parameters for a physical mechanism explaining the relationship. The most obvious place to look for the influence of solar-geophysical phenomena in weather is troposphere, and it has long been felt that the earth's magnetic field may play a role in bringing various sun-weather relationships. Earth's magnetic field is found to influence the average tropospheric pressure systems (e.g., 500 mbar levels) at high latitudes surrounding northern and southern magnetic poles. If the earth's magnetic field affects the meteorological phenomena, long term changes in geomagnetic field should produce corresponding changes in climate. This, however, has been found in the similarities in the variations of magnetic inclination and temperatures in central England since 900. A. D. Further, the 'Little Ice Age' that occurred in Britain during 1550-1700 A.D. is clearly associated with an epoch of high magnetic inclination. One possible way in which geomagnetic field may affect the weather (at high latitudes) is by its controlling influence on the precipitation of charged particles from the magnetosphere (atmosphere above 600 km). It is well-known that physical processes occurring in the magnetosphere and ionosphere (the ionized region of the atmosphere above 50 km) vary with solar activity and we have seen that certain features of weather also vary during the solar cycle. It is of interest to note that during the period 1916-1969 the length of the annual growing season (defined as the portion of the year during which the air temperature at 1.25 m above the ground exceeds 5.6°C) in Scotland appears to have been influenced by the changes in solar radiation associated with solar cycle. The length of the growing season is about 25 days longer near solar maximum than near solar minimum. A study of the northern hemisphere temperatures during 1958-1963 revealed that the average temper-

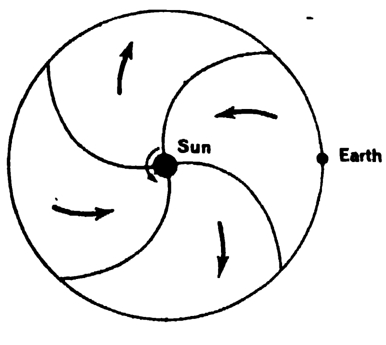

Fig. 2. The solar magnetic field lines come out radially and take a spiral form due to sun's rotation. The field is directed alternately towards and away from the sun as though it was arranged in sectors. These sectors are formed gradually and often persist for several solar rotations

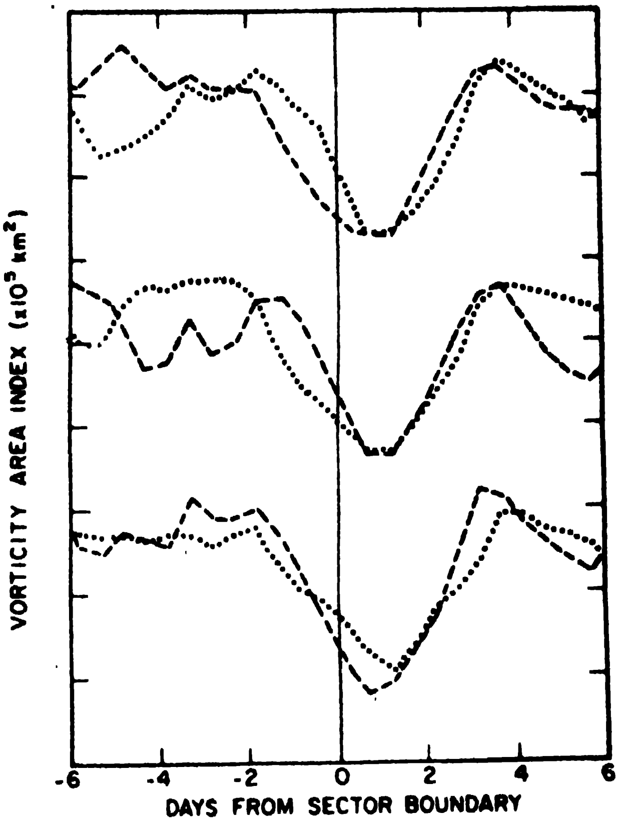

Fig. 3. Shows variation of VAI (Vorticity Area Index) on the days preceding (—) and following (+ not indicated) and on the day (o) sector boundary crosses the earth (*After* Wilcox, J. M.)

ature fell by about 0.60°C during these five years. A suggestion has been made that, as the earth's magnetic dipole moves slowly into the northern hemisphere and gradually increases the magnetic field there, there is a possibility, though in an unknown way, for the decrease of meteorological temperatures in the northern hemisphere.

The advent of satellite experiments gave a new fillip to the study of the sun-weather relationships. The solar-interplanetary magnetic sector structures measured by artificial satellites provide a meaningful parameter describing solar activity. As observed from earth, the magnetic field lines radiating from sun appear to be divided into sectors such that within each sector the field polarity is either toward (minus) or away (plus) from the sun (Fig. 2). The structure rotates with a 27 day period with a sector boundary crossing the earth about each seven days. It is observed that few days after the sector boundary sweeps past the earth, the conditions on the sun, interplanetary space and in terrestrial environment tend to be more active than average. The geomagnetic activity, as a specific example, sharply rises one to two days after the sector crosses the earth. One interesting feature observed is that the van Allen radiation belts 'breathe' in and out as the sector structure sweeps past the earth. The advantage of using the sector structure boundary to investigate effects on weather is that we are sure to using a parameter of solar origin observed at precise times near earth. Any observed atmospheric response to the passing of a sector boundary is caused by the solar magnetic structure beyond doubt.

Walter Orr Roberts, John M. Wilcox and coworkers (United States) studied the influence of solar magnetic sector structure crossings on low pressure troughs in troposphere. One of the important features of ordinary turbulence (in atmosphere or fluids) is the amplification of vorticity (curl of velocity vector of fluid or wind) by a mechanism called 'vortex stretching'. Vortex stretching is the mechanism that gives hurricances and tornadoes their destructive force. A parameter known as Vorticity Area Index (VAI) is defined as the sum of the area (in square km) over which the vorticity exceeds 20×10^{-15} sec^{-1} plus the area over which the vorticity exceeds 24×10^{-5} sec^{-1}. It is well-known that regions of high positive vorticity are associated with low pressure troughs. It is now reasonable to look for the response of the VAI to the passage of solar magnetic sector boundary to study the solar-weather relationships. It has been found that the vorticity area index reaches a minimum about one day after the passing of the sector boundary and there is about 10% increase in magnitude of VAI during the next 2-3 days (Fig. 3). This has been found to be true at all heights (200,300 camb levels) in troposphere and also it is found that the effect is not confined to a single longitude or latitude. One possible explanation extended to this is as follows. The solar influence acts as a modulator of meteorological noise. The sun introduces phase modulation so that the rises and declines of the index (VAI) are shifted in time. The solar influence can selectively advance, retard, or both, the timing of natural amplitude variations of the vorticity area index, so that in the end, minimum values of the index tend to be found at about the times the solar sector boundaries cross the earth rather than at times they are random relatively to the times of boundary passage. But no physical mechanism could be given phase shifts.

From the foregoing description we have seen that it is no longer possible to rule out the solar-weather relationships, as one scientist criticized the work of "heliogeophysics enthusiasts" as which "...produces only an impression of successful experiments in autosuggestion". The lack of a physical theory, nevertheless, bothers scientists all over. The difficulty, they say, is in defining the problem because it is not clear what is to be explained. For example. besides the correlation with sector boundary crossings there are a number of weather phenomena correlated with solar cycle, solar flares and magnetic storms.

Although the response of the troposphere to solar activity variations is not presently used operationally in forecasting, if such responses are identified on sound physical theory, solar variations may become an important tool in weather forecasting.

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A new theory for Ice Ages

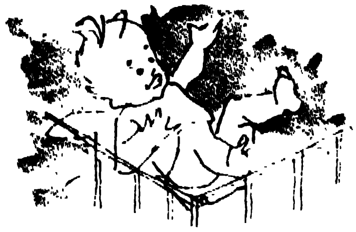
THAT the position of sun in our galaxy, the *Milky Way*, determines an Ice Age, is now a new theory in the making. Although this concept is old, it is the convincing manner in which W.H. McCrea, an astronomer at the University of Sussex, England, has based it on the latest astronomical findings that makes all the difference.

It is now an astronomical fact that our galaxy, the *Milky Way*, is spiral shaped. Two stable arms jut out of its central "core" and spiral outwardly just as a corkscrew does. Now as the sun, our special star, moves with a speed of 220 km per second, it takes nearly 500 million years to make one round about the centre "core" of the galaxy. Twice during this journey it encounters the spiral arms of the galaxy, i.e., after every 250 million years. It is this passage through the spiral arms, the dust filled clouds, according to McCrea, that triggers an Ice Age. The timing of the Ice Age after every 250 million years is in consonance with our geological records. This is what makes this sound good.

According to McCrea, the dust in the clouds give their heat to sun —brightening it up. The higher solar radiation causes more precipitation than usual, forcing the glacials to advance from the north, bringing in their wake an Ice Age. The frequent advances and retreats of glacials during the Ice Age periods have been attributed to variation in the density of dust clouds. It is claimed that only 10,000 years ago the sun passed through the *Orion Nebula*, which is when the last Ice Age was casting its cold spell on the earth. Now, whether the coming Ice Age fits in with McCrea's theory has to be seen.

D. M. S.

Jaundice



OF THE NEW BORN

C.R. KRISHNA MURTI

Neonatal jaundice afflicts infants. It can be treated by phototherapy

THE history of jaundice goes back to very ancient times. The medical sages of the Atharvaveda and the Bible were aware of its manifestation. Charaka, Hippocrates, Galen and other pioneers of the art and science of therapeutics have recorded their impressions of the symptoms of the disease. Our forefathers were also familiar with the jaundice of the newborns.

One of the commonest ailments of neonates, physiological jaundice in its extreme manifestation 'Kernicturus" can be fatal. The tender brain of the child is affected irreversibly if appropriate remedial measures are not taken. The afflicted child, if it survives, becomes a liability to the family and the community at large.

Though recognized as a widely prevalent disease of the neonates as evident from recorded medical data of the last 200 years, the root cause of neonatal jaundice became clear only in the early part of this century. In a study of 180 newborns conducted in Vienna in 1913, Hirsch discovered a correlation between the level of the bile pigment, bilirubin in the cord serum and the subsequent development of jaundice.[1]

Studies by Davidson and his associates in USA in 1941, based on the of serum bilirubin values of a large number newborns and observations reported by earlier investigators, put forward the view that neonatal jaundice could be traced to disturbances in the rate of destruction of red blood cells and the relative immaturity of liver function in the newborns.

Bilirubin and jaundice

What is bilirubin ? It is a yellow coloured substance which on spreading imparts to the skin the characteristic yellow tint in jaundice. Bilirubin (Fig. 1) is one of the end products of the breakdown of haemoglobin, the substance which gives the red colour to our blood. Haemoglobin itself is a conjugated protein made up of globin and the pigment haem. Structurally haem looks like a closed fortress formed by the fusion, of four five membered molecules called pyrrole rings. The haem molecule is of vital importance to all forms of life. While in lower species of animals, mammals and man, haem contains an iron atom in the coordinate linkage, in plants, and photosynthetic bacteria, the equivalent molecule chlorophyll, the well-known green pigment of leaves associated with photosynthesis, has the same basic structure as haem, with the important difference that iron is replaced by magnesium.

The average life of the human red blood cell is about 120 days. The red blood cell is made by the bone marrow and on aging is destroyed by the reticulo endothelial system consisting of the spleen, liver and lymph nodes. However, the bone marrow continuously manufactures fresh cells to replace the dead ones. This process of cell destruction and regeneration keeps the body in dynamic equilibrium. The degeneration of haemoglobin occurs mainly in the liver and is initiated

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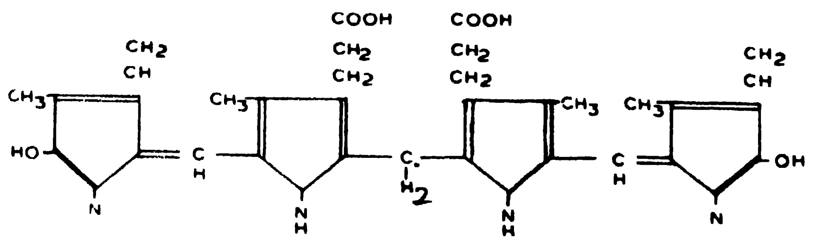

Fig. 1. Bilirubin

by an enzyme called haem—∝—methenyl oxygenase. Another enzyme named haem-∝-methenyl formylase, helps in the conversion of theoxygenated intermediate to the green pigment biliverdin, which in turn is reduced to bilirubin by biliverdin reductase, an enzyme found distributed in many tissues of the body. The reactions which bring about the degradation of haemoglobin are shown in Fig. 2.

Bilirubin is deep yellow in colour, insoluble in water but soluble in fats. The pigment attaches itself readily to the proteins of blood serum particularly, to albumin. The binding of bilirubin to albumin permits its circulation in the blood stream and its inevitable journey to the liver where it is converted in to a water soluble conjugate known as bilirubin diglucuronide. An enzyme present in liver called conjugase mediates the combination of bilirubin with glucuronic acid to form bilirubin glucuronide which is excreted now into the bile. From the bile the material is shunted to the gut where it undergoes further transformation and is eventually thrown out along with the faeces. Part of the pigment can be reabsorbed from the gut and excreted through kidney after transformation into a water soluble pigment called urobilinogen. The fate of bilirubin in circulation is diagramatically indicated in Fig. 3.

Liver and jaundice

It would be evident from the above that the liver plays a vital role in the metabolism of bilirubin. The machinery used by the liver in the process is considered to be the same or closely related to the one deployed by it in the handling of drugs and foreign molecules. The relevant cellular machinery is located in membraneous organelles called microsomes. Microsomes have been the subject of intensive investigations in recent years on account of the vital role played by them in the body's encounter with environmental pollutants and their disposal.

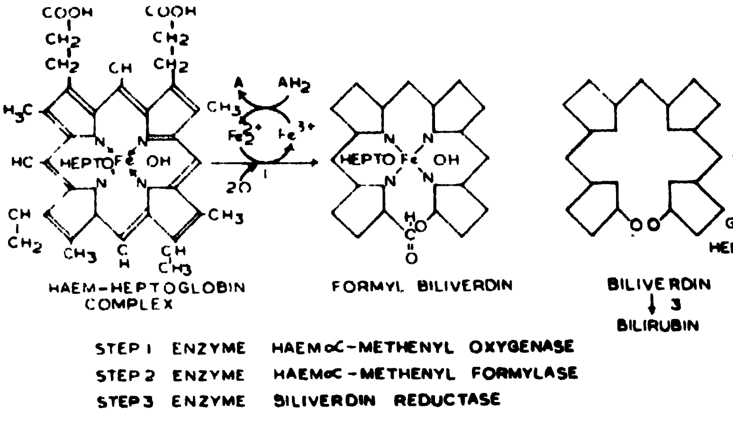

Fig. 2. Breakdown of haem by liver enzymes to bilirubin

Serum levels of bilirubin are elevated in jaundice. When the concentration of bilirubin rises beyond a particular level which can be tolerated by the body, the brain is affected irreversibly as in Kernicturus of the newborn.

The rate of destruction of red blood cells has to be relatively fast in the newborn child in order to eliminate the blood cells derived from the mother and to launch it on its own autonomous existence. By a control mechanism known as negative feedback such a rapid destruction also helps the newborn in the generation of its own supply of red blood cells which as we know are vitally inportant for respiration and survival. A certain amount of bilirubin is, therefore, always present in blood. This may exist in combination with albumin depending upon the availability of space or "binding centres" in the serum proteins. We must remember that albumin has also to transport a large number of substances to various body tissues. Among these are nutrients derived from our food and also drugs administered for treating any illness. All these compete for binding space on albumin.

Fortunately, albumin does not have the same affinity towards all molecules. At any rate, each molecule of albumin, when its binding site is free, can pick up at least two molecules of bilirubin. The bilirubin thus bound to albumin cannot get across the "blood brain barrier". This is indeed very fortunate and acts as an effective check post for this toxic substance preventing damage to the brain. However, the left-over 'free' bilirubin, in conditions where blood levels of this pigment are high, can

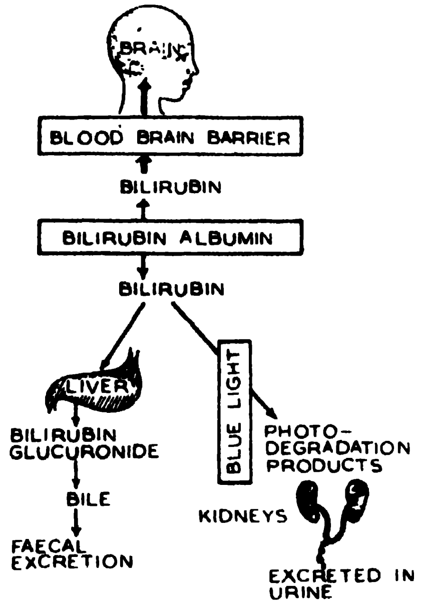

Fig. 3. Transport of bilirubin in body and across blood brain barrier

dissolve in the fats present in the membranes that constitute the blood brain barrier. The pigment can now reach target cells in the brain as outlined in Fig. 3. Neonates exposed thus to the toxic action of bilirubin become mentally retarded and show poor growth and other disabilities in later life. The mechanism by which severe injury is caused to brain cells by free bilirubin remains to be elucidated.

Origin of bilirubin

It would be obvious from the above that the most effective way of reducing the risk of its toxicity is to lower the levels of bilirubin in circulation. Where does the excess bilirubin in circulation come from ? There are three possible ways by which the load of bilirubin carried by a neonate increases: (1) there is, as we saw earlier, a rapid degradation of the residual maternal blood and a consequent stimulation of the formation of blood cells in the body of the newborn. In addition, in some babies there could be inherited defects which lead to haemolytic anaemia; (2) in a condition known as erythroblastosis common among mothers who have the ABO or Rh group incompatibility, excessive destruction of red blood cells can lead to a transfer of large amounts of bilirubin through the placenta to the baby in the womb; and (3) the liver of the neonate lacks the enzyme bilirubin conjugase and does not permit the rapid elimination of the pigment from circulation.

Therapeutic measures

One of the earliest methods adopted for lowering the serum bilirubin especially in ABO or Rh incompatibility cases was based on the complete replacement of the blood of the child with fresh blood drawn from a healthy donor. Although unfailingly beneficial, this technique known as exchange transfusion is not feasible in all cases. Besides, in many instances, there occur complications indulging death due to the administration of fresh blood to a young baby. Jaffe and others found in 1966 barbiturates to help in the rapid mobilization of bilirubin in jaundiced neonates. Barbiturates are known to stimulate the liver enzymes, "mixed function oxygenases", which mediate the breakdown of haem. However, the drug has to be used repeatedly and is not without its undesirable side effects.

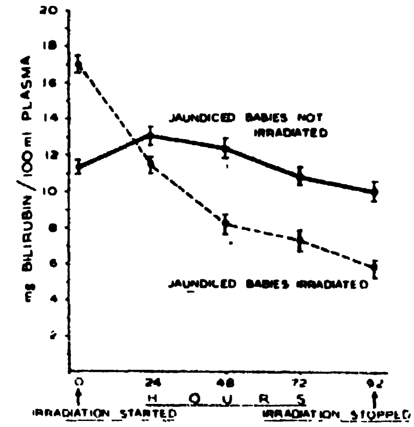

Fig. 4. Lowering of plasma bilirubin by phototherapy of neonates (study conducted at N.G. Medical College, Lucknow)

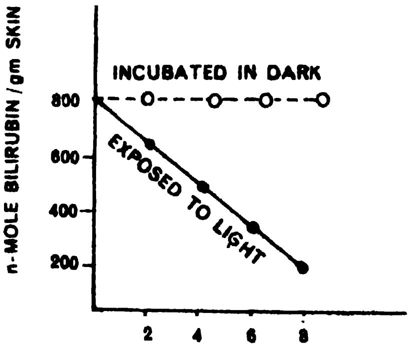

Fig. 5. Distribution of bilirubin bound to skin by phototherapy

Phototherapy of neonatal jaundice

In 1958 Cremer and associates observed that when jaundiced babies are placed under blue fluorescent light, there was bleaching of the yellow skin accompanied by significant lowering of serum levels of bilirubin. With this discovery was ushered the era of phototherapy in the management of neonatal jaundice. Since then phototherapy has been in use in several countries giving unequivocally beneficial results in white skinned children of Caucacian patients. In the case of black skinned Negroid or yellow skinned Mongoloid babies, the results have not been equally dramatic.

Phototherapy in India

Phototherapy units have been functioning in the pediatric wards of some of the hospitals in India. In the Mahatma Gandhi Memorial Hospital attached to K. G. Medical College, Lucknow, phototherapy as a routine therapeutic procedure has been in use for the last 7-8 years and about three thousands neonatal jaundice cases have been treated

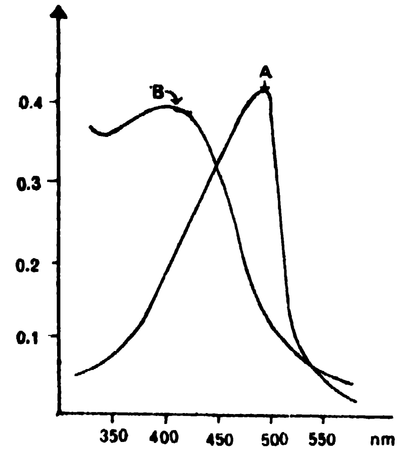

Fig. 6. Absorbance spectrum of bilirubin before (A) and after irradiation (B)

so far. The efficiency of phototherapy in reducing bilirubin levels in serum of jaundiced neonates is illustrated in Fig. 4. Out of these 40 neonates having Rh hyperbilirubinaemia (high levels of bilirubin in blood serum) and 200 neonates of ABO haemolytic disease have received phototherapy in place of exchange transfusion and have been managed successfully. The failure rate has been less than 0.1%. In this hospital alone, exchange transfusion incidence (the need for giving whole replacement of blood) in neonates has gone down markedly. Encouraged by this success, Prof. P. C. Bajpai of the K. G. Medical College, Lucknow, has submitted plans to the U. P. State Government for establishing phototherapy units in some of the neighbouring district hospitals.

Phototherapy units can be built up with indigenously available material. The source of blue light used is the common tube light. The number and location of the lights in the irradiation chamber is fixed by prior measurement of the flux of light thrown on the bed in which the baby is kept. The chambers are maintained at a comfortable ambient temperature, if necessary, by air conditioners. The babies are placed in the chamber with their eyes covered by a dark eye bandage and then exposed to illumination. At intervals the babies are turned on their bellies to expose their backs. It is possible to devise automatic turn tables so that all parts of the body of the baby are exposed uniformly to light. By finger prick method, hurting the child as little as possible, 0.1-0.2 ml of blood is drawn into capillary tubes for monitoring the bilirubin content at frequent intervals and to determine when to stop the irradiation.

Photo-oxidation of bilirubin and the role of skin

Extensive work on the clinical management of neonatal jaundice by phototherapy including follow-up studies on the babies for their behavioural performance and growth etc., has been carried out by Prof. P. C. Bajpai and his colleagues at the K. G. Medical College, Lucknow. In a collaborative programme with the author of this article and his colleagues, experimental studies have been conducted, in the Division of Biochemistry, Central Drug Research Institute, Lucknow, and lately in the Industrial Toxicology Research Centre, Lucknow, on the mechanism of toxicity of bilirubin and the photo-oxidation of bilirubin.

Using fresh human red blood cells a convenient system has been designed to explore the mechanism of the toxic action of bilirubin. When fresh red blood cells are exposed to bilirubin, haemolysis takes place resulting in the leakage of the blood pigment haemoglobin from the cell. If cells are treated with bilirubin in presence of albumin and serum lipids, the extent of damage is significantly reduced. This suggests that bilirubin combines with some essential constituent of the outer coat of RBC and triggers the disruption of the integrity of the latter. As a result, the cell which is like a sac holding the red pigment develops leaks.

The above joint team of scientists of Lucknow has also established for the first time that there is a direct interaction between bilirubin and the structural units of human skin. Thus collagen, an important component of skin, has been shown to have a great avidity for bilirubin. In fact one molecule of native collagen can bind around eighty molecules of bilirubin as compared to the mere two molecules of the pigment bound by one molecule of serum albumin.

Evidence has also been adduced to indicate that human skin forms a good matrix for bilirubin when it is acted upon by light as shown in Fig. 5. Apparently, skin provides an alternate route of disposal of bilirubin. The products arising out of the action of light on bilirubin bound to skin are water soluble and are easily transported to the kidney and eliminated through the urine as outlined in Fig. 6. Such products have been isolated from the urine voided by babies undergoing phototherapy and shown by us to be non-toxic to red blood cells. Besides picking up free bilirubin from blood, the skin also has been found to exchange the bilirubin with serum proteins. These studies have helped in discovering the key role played by skin in the detoxication of bilirubin in neonates whose liver is not functionally mature to deal with the extra burden of bilirubin by conjugation.

Inspite of the success achieved over several years, in many countries, in the management of neonatal jaundice by phototherapy, clinicians have been reluctant to adopt it as a routine procedure. It is argued that the absence of serious untoward effects in the reports available does not necessarily preclude the possibility of long-term effects elicited by light itself on the neuroendocrine system. Investigations are, therefore, in pro-

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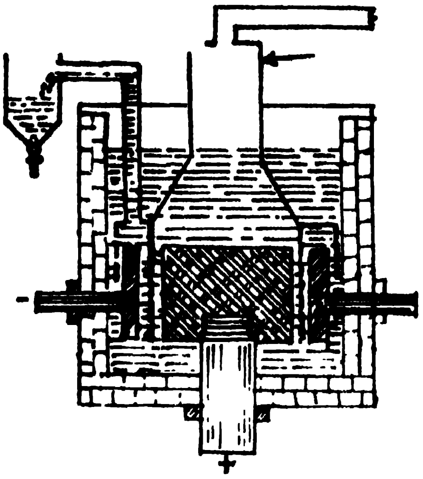

Sodium

THE UNCOMMON METAL FROM COMMON SALT

Sodium remained a laboratory curiosity until its use was found in organic reductions and in the production of aluminium. The recent impetus the sodium technology has received is owing to its use as a nuclear reactor coolant

R. S. SAPRE

SODIUM is the sixth abundant element in the earth's crust forming about 2.83% of its weight. In the combined form with chlorine it is familiar to everybody as common salt. After its discovery and isolation by Davy in 1807 by electrolysis of sodium hydroxide, sodium remained for very long a laboratory curiosity. Later, some small scale uses developed in organic reductions and in production of aluminium by sodium reduction of aluminium chloride. It was not until the antiknock compounds for gasoline were developed that the sodium demand increased substantially and improved processes for its economic manufacture were devised. Sodium technology received an impetus with the more recent use of the metal as a heat transfer medium in the liquid metal cooled nuclear reactors.

Manufacture of sodium

Sodium can be produced by thermal reduction of many sodium compounds, especially, sodium carbonate or sodium hydroxide by carbon or by metals like iron, aluminium or magnesium. Sodium chloride can also be reduced to sodium with carbon in the presence of lime. The thermochemical methods have, however, now been practically displaced by the electrochemical methods.

There are mainly, two electrolytic processes for sodium manufacture: Downs cell or its modifications, electrolysing fused sodium chloride and Castner cell or its modifications, electrolysing fused sodium hydroxide, the former accounting for major portion of the commercial production of sodium. In fused salt electrolysis, the temperatures involved are high and the solubilities of metals liberated at the cathode in the fused salts higher in the melts; there is some recombination of the metal with the gas at the anode, resulting in reduced current efficiency. This disadvantage is countered to some extent by addition of other salts which lower the fusion temperature in the bath without themselves taking part in the electrolysis.

In the Castner process, fused sodium

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hydroxide is electrolysed at 320 °C—330 °C at 4.5 to 5 V in the presence of small percentage of added sodium chloride to increase the conductivity of the bath. External heating is not necessary in large cells. The energy efficiency of the process is, however, low for various reasons. This process has the advantage of low operating temperature. But it requires relatively costly caustic soda and the efficiency is low and hence has been largely displaced by Downs process.

In the Downs cell, sodium chloride is electrolysed in a fused bath containing 58-59 per cent calcium chloride at a temperature of 575°C to 585°C. Calcium chloride serves as a flux to lower the fusion temperature which for sodium chloride alone is 804°C. The Downs cell (Fig. 1) is a refractory-lined steel shell with a graphite anode projecting inward from the bottom. The cathode is a cast steel cylindrical ring surrounding the anode and is supported by iron arms through the cell walls which also serve to conduct the current. The anode is covered by a conical bell-shaped iron or refractory dome as a chlorine collector submerged in the electrolyte. The electrodes are separated by suitable diaphrams. The annular launder around the chlorine dome collects the liberated molten sodium, which rises through a pipe to the top and out of the cell due to specific gravity difference (Na 0.88, bath 2.1) and the resulting hydrostatic head. As the temperature of the liquid sodium falls with the rise in the exit pipe, much of the dissolved calcium falls back into the bath. The hot sodium (about 110°C) is then filtered to remove the remaining suspended calcium oxide and salts etc., cooled and packed or stored under inert atmosphere.

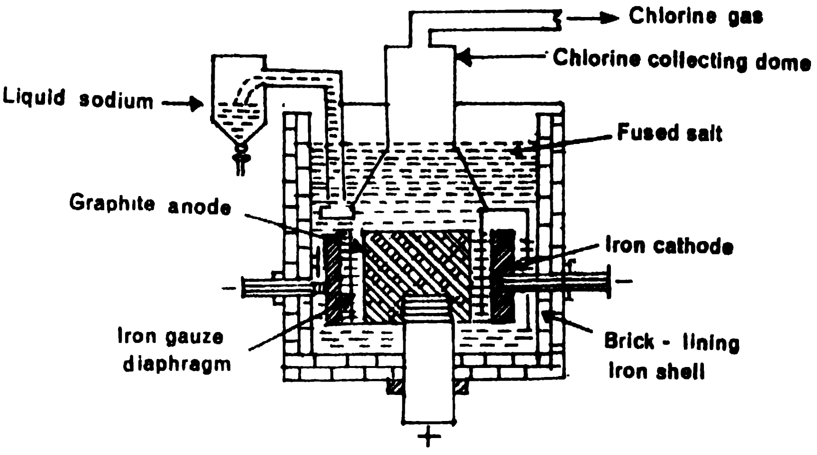

Fig. 1. Sketch of Down's cell for eletrolysis of fused sodium chloride

Energy efficiency of the cells is about 80 per cent. The cell operates at 7.5 V and energy consumption is 11 to 13 kWh per kg of sodium produced. Pure chlorine, in almost stoichiometric proportion (1.54 kg per kg of sodium) is obtained as a byproduct.

Salt is consumed at the rate of about 3 kg per kg of sodium. The salt has to be of high purity as otherwise some of the impurities are passed on to the sodium or go on accumulating in the bath with deleterious effect. The purity requirements can be stated as NaCl 99.5—99.7 per cent minimum and Ca, Mg, SO$_4$ insolubles, etc., not to exceed 0.1 per cent together.

For producing refined salt of high purity, common salt is dissolved in water and the saturated brine is treated with (i) lime—soda ash or (ii) caustic soda to precipitate the magnesium and calcium impurities, followed by barium chloride or barium carbonate treatment for removal of sulphate. In some plants the brine is treated with caustic soda, ferric chloride and barium chloride. The treated brine is allowed to settle, and then filtered. The purified, clear brine is then evaporated in multiple effect vacuum evaporators and the resulting sodium chloride crystals separated from the slurry by centrifuging, and dried in rotary driers. Alternatively, the slurry is filtered on drum filters where liquor separation and hot air drying of crystals is effected. The pure, dry salt then goes to storage or to the electrolytic cell.

Calcium chloride is also required to be pure and has to be replenished in the bath at the rate of about 0.04 kg per kg of sodium produced.

Properties of sodium

Sodium is a waxy, silvery-shining, metallic solid when fresh, but soon develops a fine, dull oxide film on exposure to air. It is comparatively stable in dry air at moderate temperature, but catches fire when heated in air to 120°C and above. It reacts violently with water and hence sodium fires are never to be extinguished with water or conventional fire extinguishers. Dry salt, soda or dry graphite are used for this purpose. Its important physical properties are :

Sp. gr. : 0.968
M.P. : 97.80°C
B.P. : 883°C
Vapour pressure at 440°C : 1 mm
Thermal conductivity at 20°C : 0.317 cal/(cm^2) (sec) (°C/cm)

Thermal conductivity at 20°C :
0.193 cal/(cm^2) (sec) (°C/cm)
Heat capacity : 0.30 cal/(g) (°C)
Heat of fusion : 27.4 cal/g
Heat of vaporization at 883°C :
1005 cal/g

Neutron cross-section : 0.49 barns

It is an excellent conductor of electricity. Commercial filtered sodium is 99.9 per cent pure. The impurities are calcium and minor amounts of iron, lead, copper, arsenic, nickle, silicon, phosphorus, sulphur, boron, chloride and sulphate. The calcium content of commercial grade sodium (Ca 400 ppm) interferes with the operation of the LMFBR and hence a much purer grade (purity 99.99%, Ca 10-20 ppm) is preferred for reactor coolant purpose. Sodium can be stored in steel drums and is available in sizes from 1 lb to 80,000 lb container. The nuclear grade is shipped under argon gas.

Uses of sodium

Chemically, sodium is a very reactive metal and is used in the production of many inorganic and organic compounds. In organic reactions it is employed for condensation, synthesis, reductions and in organo-sodium compounds.

The largest use of sodium has been in the manufacture of tetraethyl lead and to some extent tetramethyl lead as antiknock compounds in gasoline. The reactoin for TEL is :

$$4\ PbNa + 4C_2H_5Cl = (C_2H_5)_4\ Pb + 3\ Pb + NaCl$$

In the process, ethyl chloride and a lead-sodium alloy containing 10% Na and 0.1-0.2% Mg, (M.P. 400°C) in the form of small grains are heated to 70°C in an autoclave under reflux conditions and then cooled and maintained at 40°-60°C for completion of the reaction. Excess ethyl chloride is then removed by distillation and tetra-ethyl lead recovered by steam distillation. The lead residue is melted, reallowed and fed back to the process. About 1/3 kg of sodium is used per kg of TEL. The U.S. demand for sodium for this use in 1970 was estimated at about 150,000 short tons.

Table 1. Production and price of sodium

Year	Production in short tons		Price cents/lb
	U.S.	World	
1949	70,000	—	18.5
1958	125,000	150,000	16
1964	140,000	—	33
1966	160,000	—	—

A large quantity of sodium is used in the reduction of esters particularly for the production of long chain alcohols from animal and vegetable oils for use in detergent manufacture. However, this method of fatty alcohol production is now declining in favour of high pressure catalytic hydrogenation.

Sodium is used in the manufacture of the following important inorganic compounds: (a) Sodium peroxide, used for bleaching cellulose pulp in paper manufacture. It is produced by passing an oxygen-air mixture over sodium at 300°C-400°C., (b) Sodium cyanide, used in (gold) metallurgy, electroplating, etc. by reaction of sodium with ammonia in the presence of coke, and (c) Sodium hydride which is used in descaling of many metals and alloys that do not react with molten caustic soda.

Sodium is also used in the production of metal powders from their salts. Thus, titanium and zirconium are recovered by sodium reduction of the respective tetrachlorides.

Sodium as a nuclear reactor coolant

The more recent use of sodium is as a heat transfer medium in nuclear reactors. The heat produced by fission of uranium or other nuclear fuel has to be continuously removed and transferred either to the heat sink or to water for steam and power generation. A number of coolants can be used for this purpose, e.g., water, heavy water, compressed gases (CO$_2$), liquid metals (Na,Na—K,Hg,Bi), some fused salts and certain organic liquids (diphenyl). But the choice is dependent on many considerations like high purity, low neutron cross section, low melting point, high boiling point, high thermal conductivity, high heat transfer co-efficient, low vapour pressure, low half-life of radioactive products, low corrosion of metal in contact and finally low cost. Sodium is suitable on many of the above counts, including cost which is not exhorbitant compared to its advantages. Its major drawback is its high reactivity and fire hazards on exposure to air or water. Thus, though not a universal coolant in nuclear reactors, it has been used in the Liquid Metal Fast Breeder Reactors (LMFBR) being developed as the most economical power sources of the future.

Production and prospects

A few available figures on the production and price trends of sodium metal are given in Table 1. Large producers of sodium are Ethyl Corporation, DuPont and National

(Continued on page 258)

SCIENCE SPECTRUM

Earth's climate - a cyclic phenomenon

THAT the Ice Age is coming is in the air nowadays. Scientists are, however, still unable to decide what has caused its arrival. Some lay the blame on the rising atmospheric pollution; others claim that it is a result of natural phenomena such as volcanoes which are active these days; there are still others who feel that an extraterrestrial phenomenon is responsible for it. According to them, it is because the solar system is about to enter a dusty cloud in space, which would partially shut off heat and light of the sun producing the cooling. In short, there is no unanimity on one single cause. And, now, if it is added here that according to a recent research there is no apparent cause for the coming Ice Age, won't everything look more puzzling?

Bent Aaby, of Geological Survey of Denmark, Copenhagen, (*Nature*, Sept. 23, 76) says that the climate is a cyclic phenomenon, that the coming Ice Age or cooling trend is nothing unusual; it is just a phase of the cycle. This is his conclusion about the climate of north-western Europe, where he conducted research. If it is true for one region, it is so for the entire globe.

Aaby has come to the above conclusion by his study of past climatic changes. He has used raised bogs, a special type of soil and vegetable decay marsh, as an indicator of the past climates. Just as one ascertains whether it rained or not, or how much it rained the night before, from the moisture content of the soil, the raised bogs tell about the climates the surface of earth has experienced for an extended period since ancient times. However, before anything is discussed, it would be better to know what is a raised bog and how it helps in determining a climate change.

Vegetation appears wherever there is a soil lying waste. This is a common observation. What we don't observe are things that happen to it eventually. Naturally the vegetation gets wiped off when the season changes. It gets decomposed in the soil and forms a fine layer over it. The rate of decomposition depends on the external conditions then prevailing such as humidity in the environment, evaporation rate, temperature and water surrounding that location. In a word, year after year, with every seasonal change such layers of decomposed material gets deposited. The soil containing such a decomposed matter is called peat. If one examines these peat layers one by one, one could ascertain the climate prevailing earlier about that location.

A 'bog' is a marshy place. The one which contains peat is called peat bog. Raised bogs are a special class of peat bogs. They are characteristically different in that they are lens-shaped, i.e., highest in center. The quality that makes a peat bog an effective climate indicator is that it doesn't absorb water from a stream or reservoir in its vicinity or beneath it. It absorbs water only from the atmosphere in the form of moisture, dew, rain or snow.

To deduce a past climate from the peat layers, though appears simple, it is not so. For instance, if the peat is more light coloured, it cannot be inferred that it got dried up. The reason could be that then there were more rains or temperature was quite low or both. A shift in colour from light to dark does not necessarily imply that there has been a climate change. It may be that during a stable climate condition, the peat got more decomposed resulting in a colour transformation. Such a shift is ignored as a climate indicator.

To avoid errors while deducing past climates from colour shift in peat, Aaby selected five large raised bogs in Denmark. Each bog was examined at various spots so that local alterations in climate could be filtered out and only those which are widespread be taken into account. While humidity of peat at various depths was found using calorimetric technique, the age of peat layers was estimated from radio carbon methods. The age of layers was converted into calender years and was plotted against the corresponding humidity found in peat. The humidity curve so drawn was found, within certain statistical uncertainty, similar in nature to the one drawn between the population of two plant species, called rhizoped genera, and time. These plant species are good indicators of moisture content in soil as their very population depends upon it. The major fluctuations in both the curves are similar which gains support for the fact that the humidity in the atmosphere indeed had varied in the past.

The duration over which the curves were drawn is 5,000 years, a long period for generalising the findings. It has been found that there is a trend of a 260 year cycle in the humidity changes. There are some dates, however, at which shifts are not traceable, for instance, around 1800 A.D. The reason offered for this discrepancy is that the change in humidity then was too weak to be reflected in the bogs. Also, some dates around 1400 B.C. and 2000 B.C. do not tally with the cyclic behaviour. Such irregularities have been ruled out, saying that the curve reflects the changes which were due for long periods only.

Humidity in the atmosphere is related to climate in that if it increases a cooling is triggered off. If, on the other hand, humidity decreases,. it is an indication of the onset of a warmer climate. According to Aaby, it takes less than 50 years for the cooling or warming to be felt after the humidity has begun to increase or decrease. So the above humidity curves in a way indicate the climate trend for the past 5000 years and the 260 year cycle observed in it is, in fact, a picture of how climate has varied in the past.

This 260 year cycle climate looks convincing in that it agrees well with the past 1100 year climate record of England's history. For instance, the last cold climate indicated in humidification curve to have occurred in the first part of 16th century is recorded in the English history as the onset of 'Little Ice Age.' The preceding warm phase as found in the humidification curve to have occurred in mid 13th century is indicated in the records as the mediaeval warm period. Before 1000 A.D. the English record is uncertain. However, what the Danish bogs reflect about that period has been verified by ice-isotope investigation. It is claimed now that a cooling then prevailed.

Now about the future. According to Aaby's 260 year climate cycle, a cooling should come in either in the fag end of this century or the beginning of the next century, which is very much in step with the present predictions. However, Aaby says one should be cautious in predicting climate from this cycle for future. Atmospheric pollution, he says, may be a contributing factor to the arrival of Ice Age and that is the one which never figured in the period he has derived the climate cycle.

DILIP M. SALWI

Beta-decay

THE discovery of radio-activity is one of the epoch-making events in the history of human civilization. It was the end of 19th century when man had recognised the might of the tiny nucleus. This is now the most potential source of energy in the hand of man with which he can shape his future.

It was 1896 when the French scientist, Henry Bacquerel, found that uranium element (Z=92) gave out some kind of emanations which could penetrate several folds of black paper and affect a photographic plate kept on the other side. A similar phenomenon was observed later in case of other elements too. This phenomenon of spontaneous emission of rays by such elements, known as radioactive elements, was called radioactivity and the rays emitted out were known as Bacquerel rays.

Radioactivity is confined almost to the heavier elements with Z=83 to 102. It was Lord Rutherford and his co-workers who found out that these penetrating rays were of three different kinds. A simplified experiment demonstrating this is illustrated in Fig. 1. The Bacquerel rays were subjected to electrical field and thereafter to magnetic field. In both cases, some rays were found to bend towards right and some towards left.

There was however yet another part of Bacquerel rays that remained unaffected by electrical and magnetic fields. Those parts bending to the left indicate positively charged particles called alpha-rays or alpha-

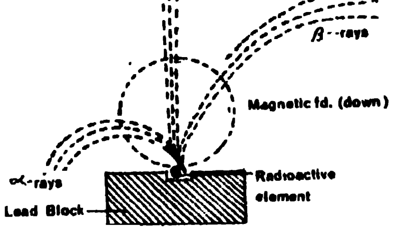

Fig. 1

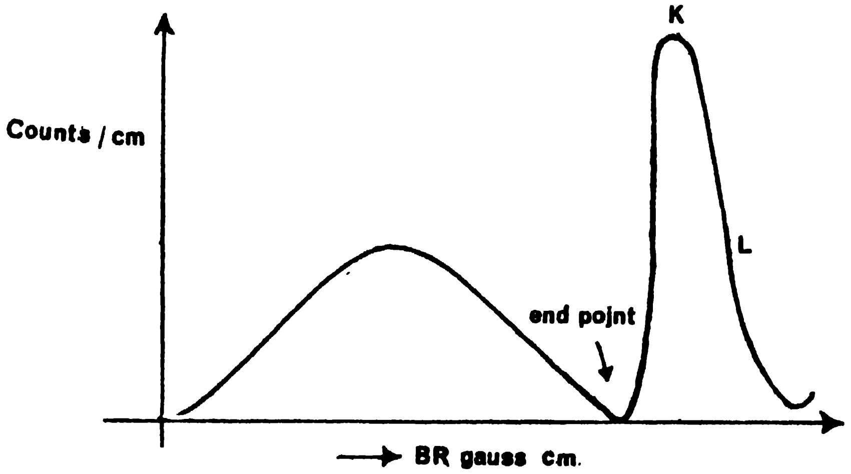

Fig. 2

particles; those bending to the right indicate negatively charged particles called beta rays or beta particles; and those going undeflected are called gamma rays. It was later found that alpha-rays are a volley of doubly ionised helium atoms or helium nuclei. The beta rays are ordinary electrons while gamma rays are electromagnetic waves of about the same or a little higher frequency than X-rays. The emission of beta particles by the nucleus is called beta-decay.

Beta-decay

Initially, spontaneous emission of electrons in radio-active disintegrations was termed as beta-decay. However, after the discovery of positron and the phenomenon of electron-capture, in which the orbital electron is captured by the nucleus and consequently a proton is converted into a neutron, the scope of definition of beta-decay was extended to include these two modes also. Thus, beta-decay is the emission of electrons (or negatrons as they are called now) or emission of positrons or orbital-electron capture. These three modes of beta-decay are shown by the following reactions :

neutron = proton + electron
proton = neutron + positron
proton + electron = neutron

Effect of beta-decay on atomic number

Atomic number of an atom is the number of protons in the nucleus of that atom. When negatron is emitted, the daughter nucleus has the same mass number as the parent nucleus but the atomic number of daughter nucleus (number of protons and neutrons in the nucleus) becomes greater by one unit from that of parent nucleus. This is represented as follows :

$$P(A, Z) = (Q\ (A,\ Z+1) + \text{electron}$$

Similarly, when a positron is emitted by a radioactive nucleus, the daughter nucleus has the same mass-number as the parent nucleus has, but the atomic number of the former is decreased by one unit from that of the parent nucleus.

The probability of occurrence of orbital electron capture is higher when the ratio N/Z is low. Here N is the number of neutrons and Z is the atomic number. In this mode, the orbital electron is captured by the nucleus and consequently a proton is converted into a neutron. The mass number A thus remains the same but the charge number Z is reduced by one unit. Table 1 abridges the statements given above.

Beta ray spectrum

Unlike alpha particle and gamma ray emission which form discrete spectra, beta-ray spectrum has the unique property of being continuous. In other words, in beta decay kinetic energies of negatrons (and positrons) assume continuous values ranging from zero to a maximum value E_{Max}. This maximum energy associated with a particular beta-decay is characteristic of the beta-active isotope. A probable form of beta spectrum is shown in Figure 2 wherefrom it can be seen that beta-particles have a maximum energy E_{Max}. Below E_{Max} there is a continuous spectrum with average energy usually less than half the maximum. Every continuous beta spectrum has a definite maximum. Height and position of this maximum depend upon the nature of the nucleus emitting the particles. From the spectrum shown in Fig. 2 it may be seen that there is an end-point of the continuous spectrum. This end-point corresponds to a definite value of energy which is the upper limit of energy for beta-particles emitted by the nucleus. This upper limit or the end point of the continuous spectrum is different for different beta-emitting nuclides. Such a continuous spectrum

Table 1

Event	*Atomic weight*	*Atomic number*
1. Negatron emission	No change	Increases by one unit
2. Positron emission	No change	Decreases by one unit
3. Electron capture	No change	Decreases by one unit

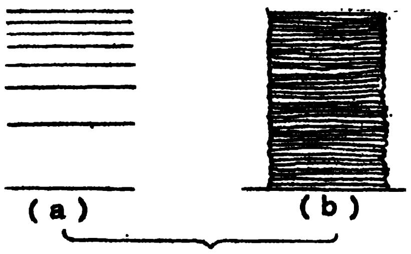

Fig. 3

is also called a primary spectrum. Sometimes, beyond the end-point of the continuous primary spectrum, sharp line(s) are also seen. Theyform what is known as the line-spectrum. The positions of these lines are characteristic of the emitting substance. The line spectra are formed due to internal conversion process shown by some nuclides whereby an orbital electron is emitted due to the release of energy by the nucleus at the time of de-excitation.

Continuous spectrum and neutrino hypothesis

From the beta-spectrum, the following observations are made :

(i) the continuous nature of beta-spectrum suggests that individual nuclei do not always emit electrons of the same energy when they decay.

(ii) in beta-decay, emitted negatrons possess energies between zero and maximum, and

(iii) average energy of the emitted particle in beta decay is only one-third of its maximum value.

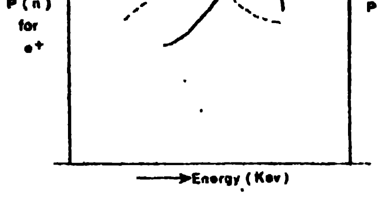

Fig. 4

The above experimental observations could not be explained till the neutrino theory was propounded by the Italian physicist Enrico Fermi. The continuous nature of beta-decay spectrum implies that individual nuclei do not always emit electrons of the same energy when they decay. To explain this, as a first thought, let us assume that it could be due to a continuous series of energy levels (continuum) in the radioactive nuclei. On the basis of this assumption of continuum, the continuous nature of beta spectrum can well be described. But what would be the form of gamma-rayspectrum in that case? Obviously, in such a case, the distribution of energy of gamma rays would also be continuous which is in contravention of our existent knowledge about the nature of gammaray spectrum, because no such phenomenon like continuous gamma ray spectrum has ever been observed. Thus our assumption of continuum fails.

Since the masses of parent and daughter elements are known, the energy change can be calculated. From such a calculation, it has been found that the energy change is same as E_{Max}, the maximum energy of the electron. Now looking carefully at (ii)and (iii) above, a query at once creeps into one' smind: Where does the 2/3rd of the energy go? If energy disappears during beta-decay, will it not violate the law of conservation of energy which is an established principle?

The enigma of continuous nature of beta-decay spectrum was ultimately solved by Fermi. Fermi proposed that in beta-decay, besides the emission of negatrons (electrons), another particle is also simultaneously emitted which takes away 2/3rd of energy which earlier could not be accounted for. This particle was named 'neutrino' by Fermi. To keep it in conformity with the laws of conservation of charge and mass, Fermi assumed that neutrino has no charge and has a negligible mass. In this way, the beta particle, the neutrino and the recoiling nucleus share energy, momentum and angular momentum available in the nuclear transition among themselves. This becomes a system involving three masses and which gives rise to continuous energy spectrum in beta-decay. The beta particle gets its maximum share of energy when neutrino is emitted with zero momentum. In this way, the neutrino hypothesis was in conformity with the laws of conservation of energy, momentum and angular momentum. As every student of physics knows, negatrons and positrons are anti-particles. On this concept, an anti-neutrino (iv) was also assumed. In this way, the beta-decay process involving emission of negatron or positrons may be represented by the following reactions :

neutron = proton + electron + antineutrino

proton = neutron + electron + neutrino

Spin and statistics of neutrino

Besides preserving the principles of conservation of energy and conservation of momentum, rules governing statistics, i. e., Bose-Einstein or Fermi-Dirac statistics, are to be preserved. To do this, certain properties were ascribed to neutrino which are as follows.

In beta-decay, the parent and the daughter nuclei have the same mass number, follow the same statistics and their angular momenta may differ only by zero or an integral multiple of h/Ω (h is Planck's constant). Since beta-particles possess spin $1/2h/\Omega$ and follow Fermi-Dirac statistics to conserve angular momenta and statistics, the neutrino too should have a spin and follow Fermi-Dirac statistics. The particle-antiparticle relation assigns the same mass, spin, charge and magnitude of magnetic moment as that of the neutrino to the anti-neutrino. These were the basic assumptions of Fermi theory of beta decay. In construction of this theory, Fermi assumed the conservation of parity (it was however later found that parity is not conserved in beta-decay). On the basis of his theory, Fermi explained the form of beta spectrum, relation between maximum energy and mean life-time in beta-transition, etc.

The interaction in beta decay—unlike forces between charged particles, nucleons and gravitational forces—has been found to be a weak interaction, i.e., electron and nucleons interact weakly. Therefore, Fermi introduced a new force-constant 'g' different from the gravitational constant 'G' and coulomb interaction constant 'k'. This has a value much smaller than the forces in nucleon-nucleon interaction.

Transition probability

The transition probability of an event is the probability in which a transition will occur between an excited state and a lower ground state. It is equal to the ratio of the number of such transitions per unit time to the total number of nuclei in the excited state. Using quantum mechanics and taking into account coulomb effect of orbital electrons, Fermi calculated the transition probability in beta decay and plotted the probability $P(\eta)$ that a negatron (or a positron) is emitted in momentum range η and $\eta + d\eta$. A curve, as shown in Fig. 4 was obtained by him. Since nucleus carries positive charge, the coulomb field therefore accelerates the positrons and decelerates the negatrons ; which is why the positron spectrum has fewer slow particles and negatron spectrum has more of slow particles. This conformed well with the experiment. It was a great win for the Fermi theory of beta-decay.

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Tar and oil shale—a potential source of oil

THE present supply of energy is heavily dependent on crude oil and natural gas with a smaller contribution from coal, nuclear power and hydro-power. It is not likely that the situation will change in the near future. Oil embargo and oil price increase has prompted extensive exploration for new oil reserves, and alternative sources of oil. This search has led to the consideration for exploiting tar sands and oil shales which contain a large reserve of oil. Canada and U. S. A. have got large reserves of tar sand and oil-shale respectively. These reserves rank as a potential source of oil for North America. According to expert opinion, the total recoverable hydrocarbon resources of U. S. A. and Canada (based on Btu equivalent) are as shown below :

	U.S.A.	*Canada*
	%	%
Crude oil	5	9
Natural gas	4	10
Coal	82	29
Oil shale	8	0
Tar sand	1	52

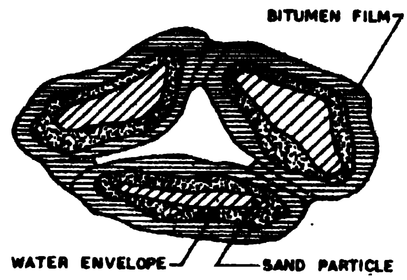

Fig. 1. Typical particles

Tar sand may be defined as sand containing bitumen, a highly viscous crude hydrocarbon material. The material is a mixture of sand, water and bitumen. A typical arrangement of tar sand particles is shown in Fig. 1. The predominant sand component is quartz. A film of water wets the sand grains and the wet particles are covered by a film of bitumen that partially fills the empty volume between them. Water fills the rest of void volume along with occasional small volumes of gas. This arrangement corresponds to a mixture of approximately 83% sand and 17% bitumen with water.

The tar sand deposits in Alberta (Canada) constitute a vast reservoir of hydrocarbons covering 31,000 sq. km. and containing an estimated 700 billion bbl. of raw bitumen. The deposit occurs at varying depths from 0 m to 800 m of overburden. The Alberta Energy Resources Conservation Board has estimated that there are about 75 billion bbl. of crude bitumen spread in the surface mineable area (with

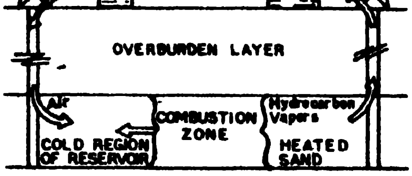

Fig. 2 Schematic diagram of combustion scheme in site process

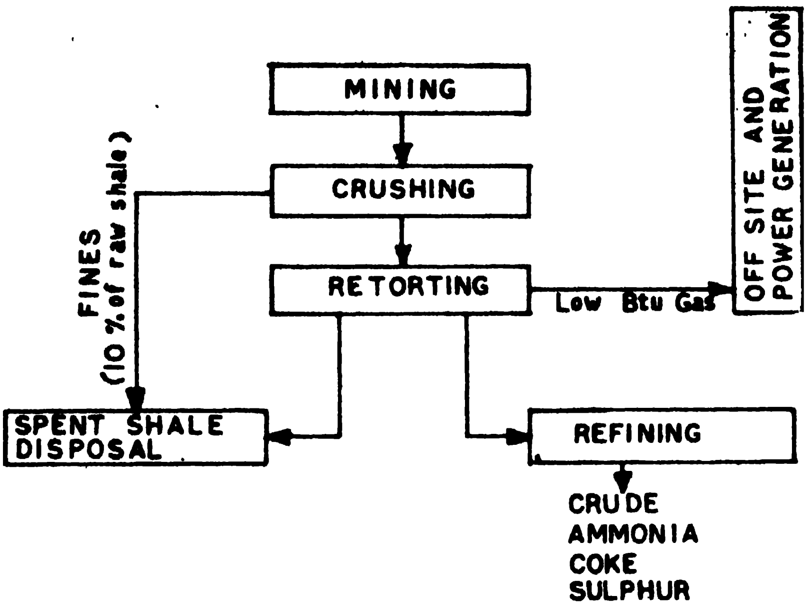

Fig. 3. Schematic diagram of stages of oil shale extraction process

overburden of 0 m—50 m or less).

The oil shale is a rock known as marlstone containing kerogen, not oil. It is a solid hydrocarbon which when heated is converted into oil and gas. The oil shale formation covers about 40,000 sq. km. in Colorado and Utah (U.S.A.) varying in thickness from 30 m to over 600 m. Under the area lie an estimated 2-3 trillion bbl. of oil trapped in oil shale . Within the upper portion of the shale bed in Colorado and Utah is a relatively uniform rich section called the Mohogany zone. This zone, about 30 m thick, is overlain by an average of 300 metre of lean shale and sandstone and contains an estimated recoverable 77 billion bbl. of oil in sections at least 10 m thick containing 30 lit or more of oil per ton. High grade oil shale is a moderately strong rock.

Due to the typical nature of the tar sand deposit, surface mining methods are applicable for exploitation of this resource. A wide variety of methods have been considered due to the variation of thickness of overburden and machineries like bucket wheel excavators, draglines power shovels, etc., are used.

For oil shale deposits underground method of mining (room and pillar) has been tested successfully, though in some places surface mining method may be applied where conditions are favourable.

The next important stage is the extraction technology for extracting crude from mined tar sand and oil-shale. Production of a barrel of synthetic crude oil with existing technology requires processing almost two tonnes of tar sand. Of the different possible methods, hot water separation method is commercially feasible. The essential steps of this method consist of pulping the tar sand with water steam and dilute caustic and then separating the bitumen from the sand by skimming

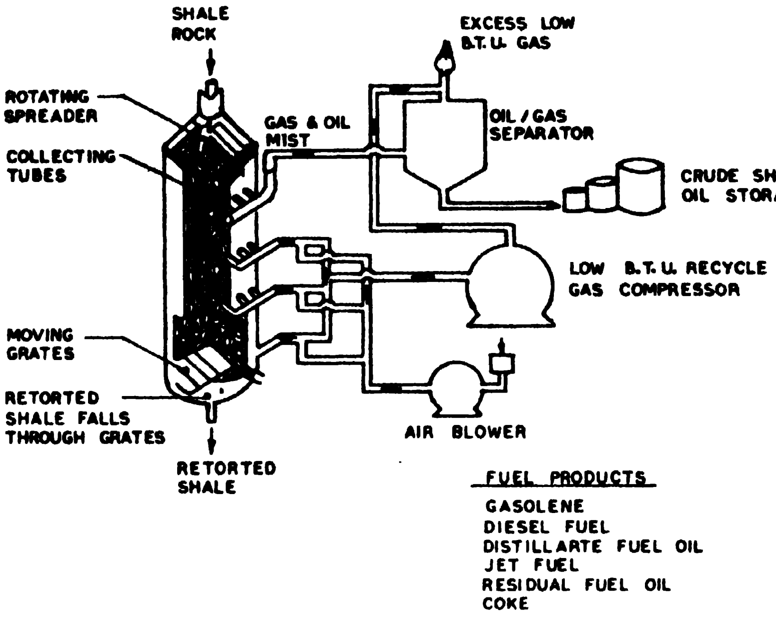

Fig. 4. Schematic diagram of the parabo oil shale retorting system.

and froth floatation. After this, the bitumen froth is mixed with a diluent (naptha) and then centrifuged to remove water and fine solids. When the bitumen has been extracted from the sand a variety of upgrading techniques are applied depending on the final product desired.

For extracting oil and gas from oil shale retorting is a suitable method. The retort vessel produces oil as a suspended mist in a gas stream. Properly sized and sampled raw oil shale is charged into the top of the vessel. After retorting the oil mist and gas stream are drawn off near the top of the vessel while the retorted shale is recovered from the bottom which is then sampled and transported to disposal area. Fig. 4 shows the schematic diagram of retorting process and Fig. 3 shows the different stages of extraction of final products from mined oil shale.

The technology for exploiting the surface minable deposits has been established but these deposits amount to only 10% to 12% of the total tar sand deposits. For the deeper lying deposits surface mining will not be economical and hence the feasibility of *in situ* method is thought of. The technology of this method is being developed. Some 90% or more of oil sand reserves are concluded to be unminable from the surface because of excessive overburden. These reserves hold truly vast stores of raw petroleum. Estimates vary widely as to the amount of oil recoverable from *in situ* deposits ; as per a conservative observation it exceeds 100 billion bbl.—also, it may be as high as 300 million bbl. Hence the attraction of the *in situ* recovery process is obvious. Experimental and pilot plant work on *in situ* process is presently being conducted by a number of companies.

Three general elements are required to produce bitumen by *in situ* process. First, a production well is drilled into the tar sand formation to permit the bitumen to be driven out to the surface. Second, an injection well is provided to introduce the driving force into the formation. Finally, a means of communication is necessary between the injection wells and production wells. In most cases, the means of communication is the tar sand itself but fracturing of the formation is sometimes used to improve communication. The major difference between various methods to produce bitumen by *in situ* process is the way in which energy is supplied to the formation.

One of the possible methods is thermal method. Here energy is generated as heat in the formation. This heat comes from directly igniting the oil in the formation and sustaining it in a state of combustion of partial combustion. The high temperature generated decreases the the viscosity of the oil and makes it more mobile. The fluid is recovered from the production well.

Similar *in situ* process of extracting oil from oil shale is also thought of for deep-lying thin beds of oil shale where underground mining will be difficult, if not impossible. Here holes are drilled into the formation and the oil shale is fractured with the use of hydraulic shock. Heat is then supplied by starting combustion in the formation. Air is pumped underground and a portion of the shale oil begins to burn causing other portion of the shale to retort. The resulting oil and gas are recovered from holes drilled into the other end of the fracture line.

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What are informosomes ?

THE ribosome is a molecular machine which carries out the synthesis of a polypeptide chain. The amino acid sequence in the chain is determined by the sequence of the nucleotides in the *m*RNA molecule. In the prokaryotic cells, such as *E. coli*, the ribosomes occur in free state in the cytoplasm, while in the eukaryotic cells, a large fraction of them is bound to the endoplasmic reticulum.

All ribosomes are formed of two subunits, a small and a large one. The functionally active ribosome in prokaryotic cells has a sedimentation coefficient of 70 S (30S + 50S) while in the eukaryotic cells, it is 80S (40S+60S). Besides the main 80S type, cells of higher organisms also contain 70S ribosomes possessing all the characteristics of the bacterial ribosomes. These 70S ribosomes are components of such intracellular organelles as chloroplasts and mitochondria. Both large and small subunits contain RNA and protein. The buoyant density of bacterial ribosomes in CsCl corresponds to a high RNA/protein ratio and is about 1.61-1.64 g/cm^3. Because of a low RNA/protein ratio, the buoyant density of 80S ribosomes is far lower than that of the bacterial ribosomes, i.e., about 1.55 g/cm.^{3}.

Informosome

Besides ribosomes, a certain class of non-ribosomal ribonucleoprotein particles (informosomes) with unique properties also exist in animal cells. Informosomes have been observed both in nuclear and cytoplasmic extracts, in a free state and also within polyribosomes. These particles do not contain either DNA or lipids. The term "informosome" has been used as a group designation for non-ribosomal (containing non-ribosomal RNA and non-ribosomal protein) ribonucleoprotein particles, the distinct feature of which are the characteristic low buoyant density (about 1.4g/cm^3), resistance to EDTA treatment and sensitivity to RNase and deoxycholate.

The sedimentation distribution of informosomes, in the centrifuge, differs from that of ribosomes and ribosomal sub-particles. Most often they exhibit a wide polydispersity in sedimentation coefficient (20S to 200S) due to variation in their sizes. In contrast to free RNA, these particles can be absorbed on the nitrocellulose filters. The homogeneous density distribution of informosomes reflects the constancy of RNA/protein ratio in the particles and the comparative low buoyant density value reflects a significant predominance of protein over RNA (4 : 1). In some special cases, e.g.: (a) reticulocytes carrying *m*RNA for haemoglobin, (b) cells infected with RNA viruses; and (c) polyribosomes of poliovirus-infected Heda cells, informosome particles homogeneous in sedimentation have been observed.

The presence of free informosomes of different sizes appears to be the general rule for the cytoplasm of all types of animal cells. Cell nuclei appear to contain much greater amount of informosomes. The buoyant density of these nuclear informosomes coincides with those of the cytoplasmic particles. Of great interest is the discovery of polyribosome bound informosomes. Treatment of isolated animal polyribosomes with EDTA releases not only naked *m*RNA but also *m*RNA-protein complexes coinciding in their properties with free informosomes.

Relationship between nuclear informosomes, polyribosome-bound informosomes and free cytoplasmic informosomes

Informosomes seem to pre-exist in the cell. An attractive hypothesis suggests that high molecular weight non-ribosomal RNA synthesized in the nucleus is complexed with proteins resulting in nuclear informosomes. These nuclear informosomes, as such or after fragmentation into smaller molecules, pass over to the cytoplasm forming a pool of free cytoplasmic informosomes ; part of the latter, after some kind of activation, interact with ribosomes, thus causing the formation of polyribosome-bound informosomes. The proteins of both nuclear and cytoplasmic informosomes display similar main bands on polyacrylamide gel electrophoresis.

Informosomal RNA

The isolation and analysis of RNA from informosomes reveals its clear difference from either *r*RNA or *t*RNA. Its sedimentation distribution does not coincide with that of ribosomal (28S and 18S) RNA or transfer (4S) RNA. Informosomal RNA, both nuclear and cytoplasmic, has a DNA-like base composition and, in contrast to *r*RNA or *t*RNA, displays a high degree of hybridization with DNA. Synthesis of informosomal RNA has been observed even in the absence of rRNA synthesis, e.g., in early embryogenesis or in selective suppression of *r*RNA synthesis by actinomycin D. This signifies that informosomal RNA, both nuclear and cytoplasmic, is non-ribosomal messenger-like RNA ("informosomal RNA").

Since all the polyribosome-bound informosomal RNA is observed as informational, at least part of it must be utilized by cell ribosomes for the synthesis of cellular proteins.

The isolation and electrophoretic analysis of protein from nuclear and cytoplasmic informosomes indicate their differences in mobility, on one hand, from histones and ribosomal proteins, and on the other hand, from main bulk of soluble proteins of the nucleus and cytoplasm. The protein is very sensitive to the oxidation of—SH groups and shows a high metabolic rate.

Biological function of informosomes

Informosomes contain messenger or messenger-like RNA and therefore it is natural to presume their informational role in the cell. Although it is difficult to pin-point their exact role for the present, various hypotheses have been put forward to suggest their significance in relation to protein biosynthesis.

(1) Informosomes are a form of regulated transport of *m*RNA from the nucleus to the cytoplasm and then into the polyribosomes. The informosomal protein may play (a) a regulatory role in detaching *m*RNA from the DNA template ; (b) in selection and processing of *m*RNA in passing through the nuclear membrane; and (c) in attaching to the ribosomes in the cytoplasm.

(2) Informosomes are a form of passive protection and stabilization of any RNA from enzymatic and other agents within the cell. Informosomal proteins may serve as "protective protein" during the passage of RNA from the nucleus to the cytoplasm and when it is within the non-translatable RNA pool or during its translatable form in polyribosomes.

(3) Informosomes are a form of regulation of protein synthesis at the level of mRNA translation. The regulation may be performed by informosomal protein at the stage of association with ribosomes or initiation of translation. However it cannot be that the presence of informosomal protein can effect the process of translation at the elongation stage in protein biosynthesis.

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Nitrogenase—the enzyme responsible for biological nitrogen fixation

INVESTIGATIONS on biological nitrogen fixation have become popular in recent years due to scarcity of nitrogen fertilizers, the high energy requirement for their manufacture, and , most significantly, their increased selling prices have produced a tremendous interest in the search for alternative technologies. Nitrogenase, a functional enzyme, responsible for N_2 fixation, was extracted for the first time in 1960 from anaerobic bacterium, *Clostridium pasteurianum* by Carnahan and Mortenson. Comprehensive literature and reviews are available now on the biochemistry, genetics and regulation of nitrogenase. Some of the basic but important information on nitrogenase is described here in brief. Nitrogenase, which may constitute upto 5 per cent cellular protein, has now been isolated from most other physiological classes of N_2-fixing organisms including aerobic bacteria, facultative anaerobic bacteria, photosynthetic bacteria, blue green algae and legume symbionts, but not from non-leguminous angiosperm symbionts. Nitrogenases from different sources have been carefully studied and have been found with only small differences, thereby justifying a unified description of a single nitrogenase. An important consideration in handling all nitrogenase preparations is the lability of the enzyme to O_2, and strictly anaerobic conditions must be maintained.

It is now well established that nitrogenase consists of two proteins: the component I consists of molybdenum and iron and designated as Mo-Fe protein, and another component II contains only iron and designated Fe as protein. Both of the nitrogenase proteins are iron sulphur proteins. The individual proteins do not catalyse any reaction and therefore cannot be called enzymes; only the combined system of both proteins is an enzyme. Both components are essential with a ratio of one or two Fe proteins for each Mo-Fe protein. The Mo-Fe protein has been crystallized but the X-ray structure has not been reported. This protein is composed of four subunits, arranged to form a parallelo-piped; structure it contains two molybdenum and 24 to 32 iron and sulfide atoms per 220,000 Daltons. The mol. weight of the Mo-Fe proteins varies in the range of 100,000—300,000. It is also inactivated by oxygen, although not as rapidly as the Fe-protein. The Fe-protein is composed of two identical ellipsoidal subunits; it contains four iron and four sulphur atoms per 60,000 Daltons. The Fe-protein is smaller of the two with a mol. weight in the range of 50,000 to 70,000. It is very rapidly inactivated by oxygen. The electron paramagnetic resonance (EPR) of the Mo-Fe protein is unique with resources at *g* value of 2.01, 3.67, and 4.3 attributed to some of the iron atoms. This spectrum proved useful for kinetic and physiological studies. The EPR spectrum of the Fe-protein is not unique with resonances at *g* value of 2.0, resembling the spectra of ferrodoxin. The amino acid compositions of purified nitrogenase have been determined but are not detailed here. The Mo-Fe protein contains all common amino acids ; there is a preponderance of acidic amino acids over basic ones, as is expected in a protein whose isoectric pH is about 5.0. The Fe-protein is noteworthy for its lack of tryptophan, which can be used to verify the purity of the preparations from foreign proteins.

The term nitrogenase is used to

denote the enzyme system that catalyzes the ATP dependent reduction of N_2, and does not include auxiliary enzyme that supply reducing power or ATP. Both ATP and a suitable reductant are essential for nitrogenase activity with the requirement of 4 ATP molecules for each two electrons transferred by nitrogenase. This usually large energy requirement for nitrogen fixation is surprising because the overall reaction is energy yielding :

$$3H_2 + N_2 \rightarrow 2NH_3 \; ; \; \Delta F = -7.95 \text{ Kcal/mole}$$

Nitrogenase is supposed to be a versatile enzyme and its versatility as a reducing catalyst was recognised with the discovery that nitrogenase can reduce a number of alternative substrates, such as H^+, acetylene, cyanide and azide. These reactions proved to be important both for study of the mechanisms and as useful analytical tools. Due to substrate versatility of nitrogenase and, specifically, the reduction of acetylene to ethylene coupled with gas chromatography analysis has been broadly implemented as an assay for nitrogen fixation. The rapid advancement in every aspect of nitrogen fixation studies would have been almost impossible without this technique. It is hoped that much more nitrogenase biochemistry would have to be unravelled before the elucidation of nitrogenase reaction at molecular level.

Further reading

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EMS—a potent mutagenic agent

HUGO DE VRIES, a Dutch Botanist once observed quite a few variable types of a flowering herb, the evening primrose (*Oenothera lamarckiana*). We also occasionally come across a black coloured butterfly in an area where the common race is gray coloured or find a short statured dwarf lamb with bent legs in an otherwise normal herd. The occurrence of such a discontinuous variant, if investigated from a geneticist's (i.e., a biologist who specialises in the field of heredity or genetics) point of view, might prove to be the case of mutation (the term owes its first application in life science to de Vries himself). Webster's English Dictionary gives the meaning of the word 'mutation' as a hypothetical sudden fundamental change in heredity, producing new individuals basically unlike their parents. Students of genetics, however, regard this often encountered phenomenon of mutation as any sudden stable heritable change in the hereditary substance. With the advancement of our knowledge we are gradually coming to know that in nature mutation has its role in shaping the hereditary material (germplasm) of almost all living beings. Interestingly, quite a number of heritable human diseases are now known to be the result of mutations in the chromosomes (i.e., the subcellular vehicles of carrying specialised hereditary codes or messages from parents to their offsprings) which pass from mother and father to the offsprings in the process of procreation.

Muller (1927), investigating on fruit fly (*Drosophila*) and Stadler (1928) working on the common shrub (*Datura*), revealed that mutations could artificially be caused by X-rays. At present a large number of the mutagenic agents are known. These agents are either physical (like ultraviolet rays, X-rays, γ-rays, neutrons, β-particles, etc.) or chemicals. In fact the list of mutagenic chemicals has already been very long (e.g., ethyl methane sulphonate, ethylene sulphate, ninitroso-N methyl urea, di-ethyl sulphate, hydrazine, hydroxylamine, nitrogen mustard, etc.) and new members are continuously being added to it. Of all the chemical mutagens, however, ethyl methane sulphonate (EMS) seems to be the most widely used now-a-days by the mutation research workers, particularly those working on crop plants.

Out of the numerous radiomimetic chemicals now known, EMS ($CH_3 \, SO_2 \, OC_2 \, H_5$) has been found to be effective in a wide array of organisms and a much effective mutagen in higher plants.

The chemical mutagens like EMS generally cause mutation by akylation of purine and pyrimidine bases of the nucleic acid. The alkylation is followed with guanine moiety at N_7 position by adenine at N_3 and cytosine. However, no reaction with thymine (T) has yet been detected. So the preference of reaction of EMS to the three nitrogen bases, out of four present in DNA, could be shown as: guanine (G) >adenine (A) >cytosine (C). The tertiary phosphate groups of the sugar-phosphate backbone which together with any of the nitrogenous bases form the units of the DNA are also alkylated, but to a smaller extent, although there is no indication that this reaction has got anything to do with inducing mutation.

The mechanism by which mutations are induced by EMS is thought to be either transition of one of the (GC-AT) base pairs through the ethylation of guanine by erroneous pairing or their deletion from the DNA leaving a 'gap' in the sequence of the bases. But both transition and transversions have also been postulated to occur following depurinization. The genetic consequences of 'gaps' are still undetermined. But several possibilities, as stated by different workers are : (1) Any of the four bases in the DNA may be incorporated opposite to a 'gap' and result in a base pair transition and transversion or in restoration of the original base-pair sequence (Bautz and Freese, 1960) ; (2) Kreig (1963) has suggested that 'gaps' may lead to single base deletion; (3) Freese and Cashel (1964) found after exposing DNA to low pH that cross-linkage of DNA had occurred, and they suggested that the initial event for the cross-linkage was a depurinization induced by the low pH, and (4) Brooks and Lawley (1963) have suggested that sites of depurinization of heavily alkylated DNA may occur proximately enough in the two DNA strands resulting in breakdown of the DNA chain.

In contrast to its effectiveness in inducing point or gene mutations through the changes induced in DNA, the ability of EMS to cause chromosome breakage involving the simultaneous breaking of the accompanying proteins is far less impressive. In an experiment with maize and barley, chromosome breakage was found to be relatively an infrequent event and majority of the point mutations induced by this chemical were thought to be unassociated with small deletions.

Besides, use of EMS as a chemical mutagen has many practical advantages like: (a) It possesses greater solubility and rate of it's hydrolysis is slow (half life is 26 hrs. at 30°C). Hydrolysis occurs in following way,

$$CH_3\,So_3\,OC_2\,H_5 + H_2O$$
$$= CH_3\,So_3\,O^- + C_2\,H_5\,OH + H^+$$

(b) It is less toxic, so higher concentrations may be administered to induce more genetic changes; (c) It causes more point or gene mutations than chromosomal aberration; (d) More linear type of curve for mutation, at least for some crop plants, could be obtained with EMS than with radiation. (e) Treatment with EMS at particular stages of 'S' phase of cell dividing cycle could produce particular type of chlorophyll mutants (swaminatean, 1969); (f) MacKey (1967) concluded that the alkylating agents have a reaction pattern more suited than ionizing (X- or α-rays) for breaking down buffering characteristics of polyploid germplasm and for creating maximum of genic deviations; and (g) More positive micro-mutations (those mutations which can be recognised and estimated through biometrical procedures only) affecting yield, and consequently having immense breeding value, could be produced by EMS treatment (Gaul, 1967).

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Cell membrane—rigid or fluid structure ?

CELL is a structural and functional unit of a living cell. It is bounded by a membrane known as cell membrane. Cell membrane plays a vital role in physiological activities of the cell. Its semi-permeability regulates the transport of various substances like sugars, amino acids and minerals into and out of the cell. Other functional aspects have already been discussed in detail (*S.R.*, Jan. 1976). Professors E. Gortan and F. Grendel of the University of Leiden studied the structure of cell membrane in detail and proposed a model in 1925. According to them, cell membrane is composed of proteins and lipids and that the lipids are in the form of bimolecular leaflets. After this, extensive work has been done on the structural and functional

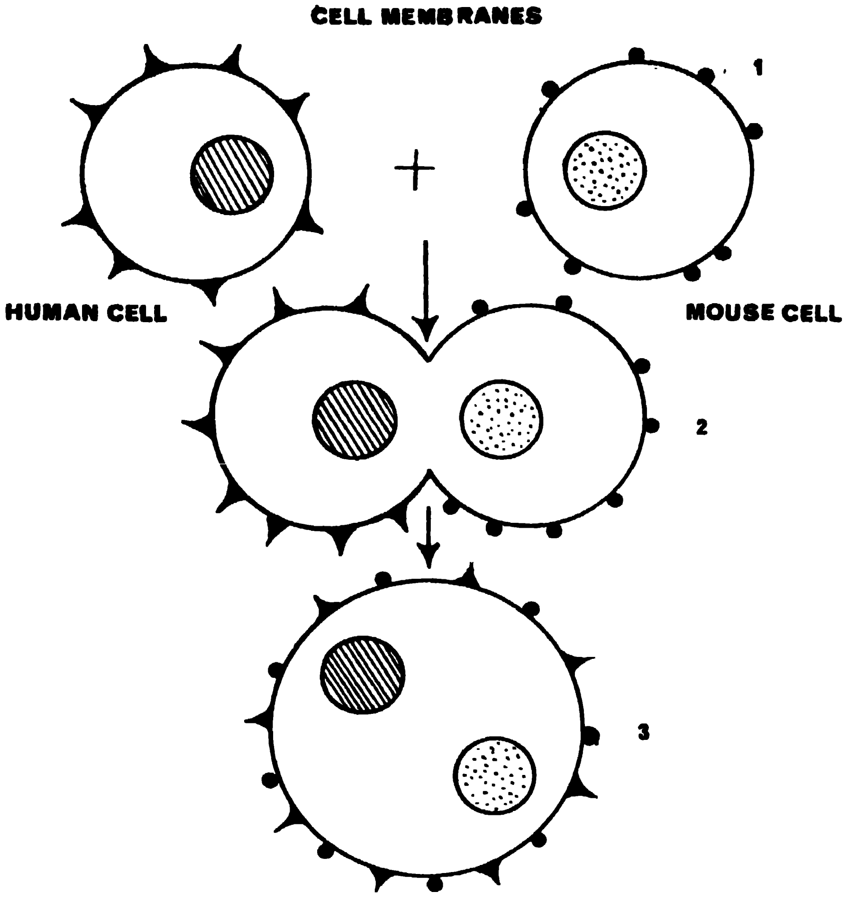

Fig. 1. Hybrid cell experiment: human and mouse cell, each with its own antigens as fused by means of a virus (*Scientific American*, May 1976)

aspects of cell membrane. However, a definite knowledge about the cell membrane state, that is, whether it was a rigid, non-deformable structure or a fluid dynamic structure, was not available until 1970. The first report regarding its state appeared in 1969 by J. Klent Blasie and C. R. Worthinton of University of Michigan. Their X-ray diffraction studies on rod cells of retina revealed that rhodopsin, a light-sensitive principal protein of the cell membrane of the retina, was mobile along the surface membrane and existed in the liquid state.

In 1970, Larry D. Frye and Michael A. Edidin of Johns Hopkins University presented a definite proof of the fluidity of cell membrane. They employed immunofluorescense technique in their studies. They produced hybrid cells of human and mouse cells with the use of virus and traced out the surface antigens of the heterokaryon with the help of antibodies tagged with fluorescence dye, fluoresceine. They observed that human and mouse cell surface antigens were confined to their own half of the hybrid cell, forming flourescent harlequins. Within an hour the human and mouse antigens moved over the surface of the heterokaryon and got distributed in a random pattern. The above experiment indicated that surface antigens are free to move in the plane of the cell (Fig. 1). In 1971, Frye and Edidin confirmed the fluidity of the cell membrane with the help of another set of experiments. They first produced antidodies against lymphocyte cells of mouse and tagged them with fluorescent dye. The antibody coupled with dye was then incubated with the lymphocytes. They found that divalent antibodies bound with surface antigens in the form of small patches. Later on, they observed that divalent antibodies-antigens complex migrated to one pole, forming a cap-like structure (Fig. 2). The above phenomenon of patching and capping of the complex could only be possible when the cell membrane existed in the form of fluid. These findings completely ruled out that cell membrane is a rigid solid structure, organised like a sandwich with molecular layer of lipid at the centre. According to the new concept, cell membrane is two-dimentional fluid bilayer of lipids into which the proteins (which are responsible for most of the functional properties of membranes like transport, intercellular communication and energy transduction) are inserted and that at

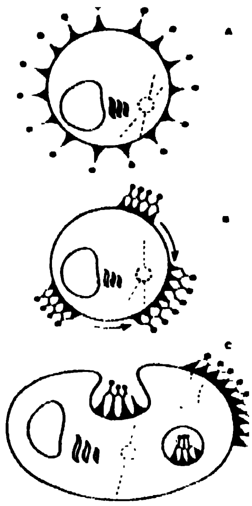

Fig. 2. A. Antigen is normally distributed diffusely over the surface as revealed by labelling with monovalent Fab fragment, B. Divalent antibody crosslinks antigen molecules and clusters them into a patchy distribution, even in metabolically inactive cells, C. If patched cells are warmed from 20° C to 37° C and are metabolically active, patches move to one pale to form a cap and there is pinocytosis or ingestion of labelled membrane

least in some cases these proteins are in the plane of the membrane. In 1972 Singer and Garth L. Nicolson of the University of California integrated these and other observations into their model of cell membrane structure called the "fluid mosaic model" which served to popularize the concept of cell membrane now widely accepted. This model can also explain the restricted mobility of cell junctions where cells make contact with each other.

It is, therefore, concluded that it is the fluidity of cell membrane which can explain certain dynamic properties of the cell like pinocytosis, patching and capping. Scientists in many laboratories are busy exploring more information regarding the fluidity of cell membrane. In particular, they are attempting to study the interactions of the membrane proteins and various fibrous components of the cell such as microtubues and microfilaments that are believed to play a role in controlling the distribution and movement of some membrane proteins.

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Of rodents, flowering of bamboos and famine

RODENTS represent squirrels, beavers, porcupines, moles and, of course, mice and rats besides a host of other animals. They are distributed all over the world and have extensive habitat condition from underground, terrestrial to arboreal areas. They can leap, run or climb and some can even glide. Diverse in forms, they are one of the most adaptable and resourceful animal groups; due to absence of any family planning (!) they can maintain a sizeable population despite predators and control measures.

Rodents exhibit a peculiar mode of feeding and perhaps there is no edible vegetable substance that a rodent would not eat. Normally a rodent would first break up its food by gnawing, nibbling or scraping at it with its front or incisor teeth; four of these chisel-shaped cutting implements (incisors) last all through their life. Besides incisors, they also possess the "grinder" or molar teeth, which crush the food after being roughly cut by incisors. Unlike carnivores, canines are absent amongst rodents.

Rodents show versatility in adapting themselves to different surroundings. Changes in surroundings could also produce variable colour pattern in the same species. During winter many of them undergo hibernation, which may perhaps be only a long undisturbed sleep (e.g., Marmots) or going underground with hoarded food to overcome the freezing cold. Some, even like old day's rulers, change from winter to summer resort, but this seasonal migration may also be directed by scarcity of food. Monsoon rains often drive many an outdoor animal to the domestic warmth (e.g., common house rat). They need more food and consequently demand a large share from their remote kins, the human beings. Even during drought, alternative foods available are sufficient to keep their population alive and, of course, with bumper crops numbers increase, population booms and they devastate vast areas of the country. Grains of all sorts, high yielding, resistant, dwarf, are attacked at every stage of growth, from the period before sowing to post-harvest period.

Although precise data on losses are not available, in India rodents are believed to destroy annually around 10 million tonnes of food worth rupees one thousand crores. Besides destroying food grains, rats and mice spread diseases like bubonic plague, typhus fever, influenza of horses and perhaps many others yet to be fully understood.

In north-east India, where at least 26 species of rats and mice occur, the special significance of rodents is well recognised. Out of the states in the region. Mizoram has often been in the news because of the damage of crop by rats leading to near famine or famine condition. There are two different recurring types of famine in Mizoram called "*Thingtam*" and "*Mautam*" which appear alternately with a cyclicity of 30 years and 18 years, e.g., Thingtam in 1881 was followed by Mautam in 1911, after a gap of 30 years and the next Thingtam occurred in 1929, i.e., after 18 years and so on. As early as 1881, according to the official report of Colonel E. R. Elles, it was recognised that the famine arose from depredation by rats which multiplied excessively the previous year owing to the ample food they obtained from seedlings of bamboos. The name Mautam was derived from the variety of 'Mau bamboo' and 'Thingtam' from the variety of 'Rawthing bamboo'. The famines always coincide or appear soon after flowering of these bamboos. From the observation of local people it appears that the gestation period of this rat is 31 days and the young takes about 4 months to become adult; the rats apparently migrate in large numbers through fields and even cross

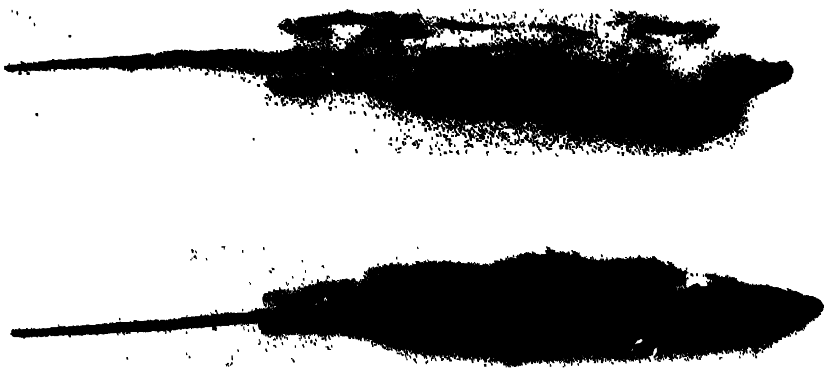

Fig. 1.

small rivulets. Bamboos flower from April to June and the rats destroy crops in early winter as they become ready for harvesting. In other words, bamboo seeds have a triggering mechanism to lead the rat population to a boom. According to the result of the preliminary analysis of bamboo seeds carried out at the Forest Research Institute, Dehra Dun, it has become clear that the seeds have a high protein content (nearly 12%) and very high starch content (50%), besides vitamin A. All these factors contribute to the nutrition of rats. But how they trigger off their reproductive cycle is yet to be understood. For this purpose and also to clearly understand the actual relationship between bamboo flowering and increase in the number of the so called bamboo rats, a project is underway to work on density and population structure, natural history and reproduction, eco-physiology of bamboo thicket and physiology of bamboo flowering. The Life Sciences Departments of University of Delhi and North Eastern Hill University, Shillong, in collaboration with Agricultural Research Complex of ICAR, Shillong, would be the functional units and Professor M. R. N. Prasad of Delhi University would coordinate biological studies. As 1977 is the next expected year for Thingtam, the timing for the project, needless to say has been correctly set and some good results are expected which may lead to plan a long term control programme of bamboo-rats in Mizoram.

It may be stated that "Bamboo-rats" associated with famine and flowering of bamboo are not *Cannomys badius* (Hodgson) and *Rhizomys pruniosus* Blyth which are commonly called bamboo-rats. In reality, these rats, in which tail is much shorter than the head and body, eyes are smaller, limbs are short and incisor teeth project out, have never been definitely seen in large numbers or to have destroyed standing crops on a large scale. On the other hand, from the available report and from the material collected by Zoological Survey of India, it appears that white-bellied rat, *Rattus niviventor* Thomas, (Fig. 1) group and the Himalayan rat, *Rattus nitidus* Hinton, group cause major damage. Both these species are well distributed in major areas of north-eastern region.

In the meanwhile, a national rodent control programme has been launched by Indian Council of Agricultural Research. Inspite of expenditure involved in such a colossal job, field studies have shown that the cost benefit ratio in such an operation ranges from 1-75 to 1-100.

However, a great deal of rodent control programme depends on training and subsequent role of trainers who would undergo this training course. The training would involve identification of field rats, their habitat and application of control techniques. Common species of field rats may be identified by distinctive colouration, type of body hairs, size of body and tail, etc., besides habit and habitat conditions.

Efforts have already been directed in this direcion; NSS volunteers are working inMizoram, state Government is paying monetary incentive, ICAR is providing extension service and people have become aware that for the first time a real war has been launched to protect them from the dreadful "Thingtam" of 1977.

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The anaemic icefishes of antarctica

MOST of the text books on animal physiology mention that all vertebrates have red blood corpuscles, and that the colour of the blood is due to the pigment haemoglobin. It is well-known that in the primitive lamprey, the respiratory pigment differs a little from haemoglobin. The leptocephalus larva of the eel does not have red blood corpuscles; these develop only when it metamorphoses into the adult.

However, it may surprise one to know that some adult bony fishes do not have red blood.

These fishes, all found around the Antarctic continent, belong to the suborder Notothenioidei of the order Perciformes (perch-like fishes). The family is *Chaenichthyidae*, and to date some sixteen odd species, belonging to ten genera, are known. They are:

(1) *Chaenichthys rhinoceratus*
(2) *Chaenichthys rugosus*
(3) *Chaenocephalus aceratus*
(4) *Chaenocephalus bouvetensis*
(5) *Chaenodraco wilsoni*
(6) *Champsocephalus esox*
(7) *Champsocephalus gunnari*
(8) *Chionodraco hamatus*
(9) *Chionodraco kathleenae*
(10) *Chionodraco myersi*
(11) *Cryodraco antarcticus*
(12) *Cryodraco pappenheimi*
(13) *Dacodraco hunteri*
(14) *Neopagetopsis ionah*
(15) *Pagetopsis macropterus*
(16) *Pseudochaenichthys georgianus*.

The accompanying map (Fig. 1) shows the distribution of these fishes in and around the Antarctic circle.

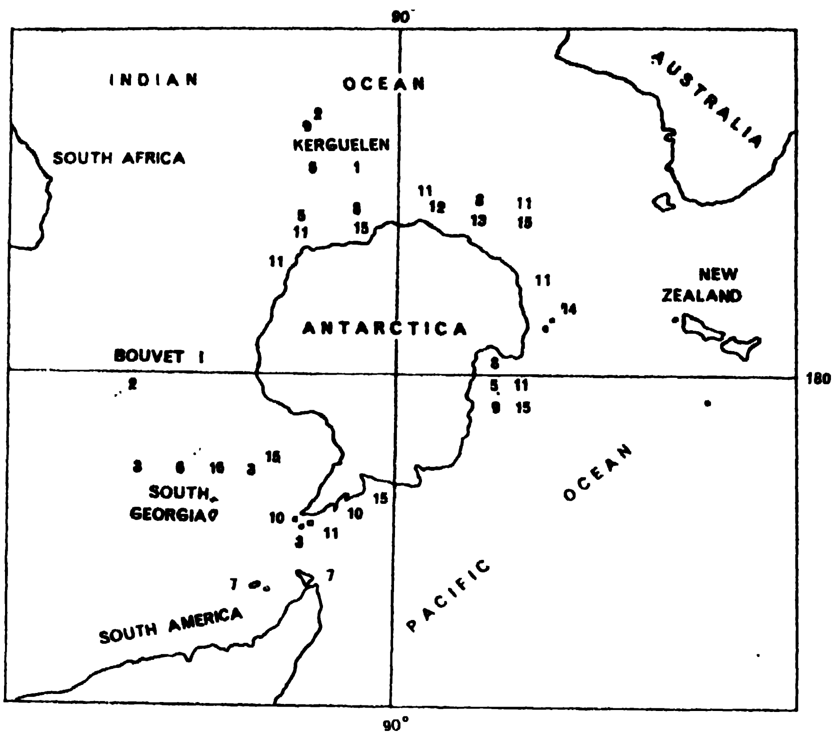

Fig. 1

These fishes are known as icefishes from their transparency and also as crocodile fishes from the pointed snout bearing numerous sharp teeth. The largest species, *Chaenocephalus aceratus*, grows to over 60 centimetres long, and, except for a few dark spots arranged in vertical bands which help the fish to merge with the stems of kelp, the body is transparent. They live along the continental shelf and near the bottom of deep fjords, at temperatures of 1.7° to 3°C.

Even though the earliest member of this family was discovered in 1844 by Sir John Richardson from the Kerguelen Islands, the first reference to colourless blood in these fishes was as late as 1931, by L. Harrison Matthews in his book "South Georgia", where he mentioned that their gills were white instead of the usual red. Another sixteen years were to elapse until a second account, this time by Nybelin in 1947, quoted Ditlef Rustad regarding the colourless blood. This physiological anomaly led to a spurt of investigations in the late fifties and early sixties, mainly by Rudd, Hureau and Spillmann, Steen and Berg, Hemmingsen and Grigg, Walvig, etc.

The blood of these icefishes is transparent, with a light yellow tinge. If left in a tube, it clots within a couple of minutes. When centrifuged, the white blood corpuscles—less than 1% of the blood in volume—separate at the bottom, leaving above them a fluid as colourless as water. If the blood is vigorously aerated, it takes up approximately 0.7% by volume of oxygen. This is the amount that can be dissolved in plasma. Against this, the red blood of other notothenioid fishes has dissolved oxygen levels as high as 6% by volume; here, however, 90% of the oxygen is bound to the haemoglobin in the red blood corpuscles.

It is possible to examine the blood corpuscles even in a preserved fish by removing the clotted blood from the bulbus arteriosus—the dilated part of the aorta near the heart. The soft opaque clot, when gently pressed with a dissecting needle, breaks up into the component cells. However, the nearly transparent clot similarly removed from icefishes cannot be disintegrated into individual corpuscles, having a rubbery consistency. Walvig, studying the spleen—one of the blood-forming organs, apart from the kidney, liver and upper alimentary tract, failed to find any evidence of erythropoiesis (manufacture of red blood cells).

The question now arises: How icefishes overcome this handicap? After all, a fish nearly 60 cm long has to have a reasonably efficient method of oxygen storage and mode of transporting this oxygen to distant tissues and organs. As seen earlier, the low percentage of dissolved oxygen in the plasma is entirely insufficient for an active life. Little is known about the fish's way of living, but the

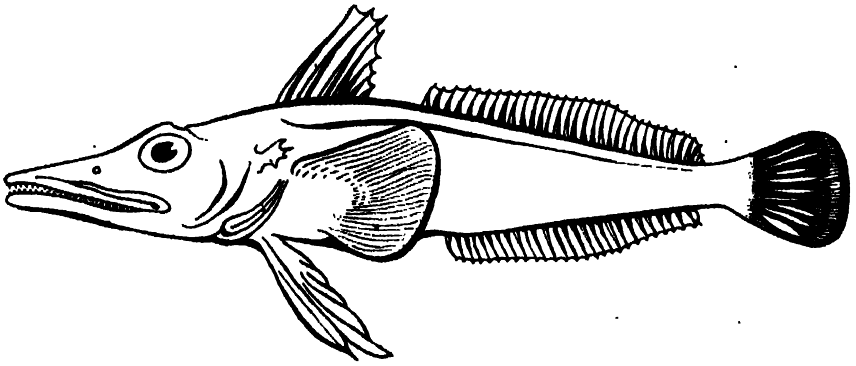

Fig. 2

large head and mouth with a narrow body and tail suggest a lethargic mode. Rather than actively hunt its prey, the icefish might remain motionless, waiting for an unwary fish to come near enough to be snapped up by a quick movement of the jaws. Here, the nearly transparent body would serve as an efficient camouflage. The large mouth enables fairly big prey to be taken in a single bite, with minimum exertion. The icefish can then conserve its energy by resting while it digests the food.

To replace the oxygen removed from the plasma, an efficient intake of oxygen from the environment would be needed. Although the gill chambers of the icefish are quite large, the total area of the gill surfaces is not exceptional; moreover, the membrane covering the gills is thick, not favouring fast gaseous exchange. The icefish almost completely lacks scales, so that it might be thought that an efficient oxygen exchange might help in the kind of skin respiration that takes place in amphibians such as frogs and newts. The skin is, in fact, richly supplied with blood vessels, but this advantage is offset by the large space intervening between the blood vessels and the sea water surrounding the fish.

Since the respiratory exchange in the icefishes does not appear to be unduly efficient, it is likely that these fishes overcome this handicap by having an efficient circulation of body fluids. Their heart is unusually well developed; in fact, the only red muscle in these fishes is found in the bulbus arteriosus. But, even an unusually large volume of blood circulation alone would not enable the icefishes to exist comfortably. It is here that the low temperatures of their environment help. It is well-known that the metabolic activities of cold-blooded animals—and this includes their oxygen consumption—double with a rise in temperature of every 10°C. More oxygen can go into solution in sea water at lower temperatures. The stable environment provided by the cold, well-aerated deep water is also accompanied by a high level of productivity. Even with the rich food supplying their needs, the icefishes migrate from offshore to deeper waters with the onset of summer, thus avoiding an increase in their metabolic rate. Only by the low and stable sea water temperature and the abundant supply of food and oxygen found in the Antarctic can the icefishes succeed in their struggle for survival.

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Crabs - are they nutritious?

FISHES and crustaceans are rich sources of protein. The crustacean fishery mainly consists of prawns, lobsters and crabs. In India crabs are considered cheap food, consumed mostly by coastal inhabitants and do not fetch high prices as prawns and lobsters do.

Edible crabs of India

Whether a crab is edible or not depends mainly on the yield of its edible meat, the effort in its catching and its sufficient marketable surplus. In India, most of the commercially important edible crabs caught in the marine and brackish water region belong to the family *Portunidae* (Fig. 1).

In addition, *Thalamita prymna* and *T. crenata* of the family Portunidae, *Matuta lunaris* and *M. planipes* of Calappidae and *Atergatis integerrimus*, *Eriphia laevimanussmithii* and *Ozius rugulosus* of Xanthidae are eaten in some coastal regions of our country. Some species of *Macrophthalmus* (family Ocypodiae) are also consumed by fishermen of Goa. Estuarine crab, *Varuna litterata*, is eaten in Bengal, while among freshwater crabs *Paratelphusa spinigera*, *P. jacqueimonti* and *P. hydrodromus* are popular in some regions like Goa, Maharashtra, etc.

Habitat and habits

Crabs are found in a variety of habitats. Most of them are marine,

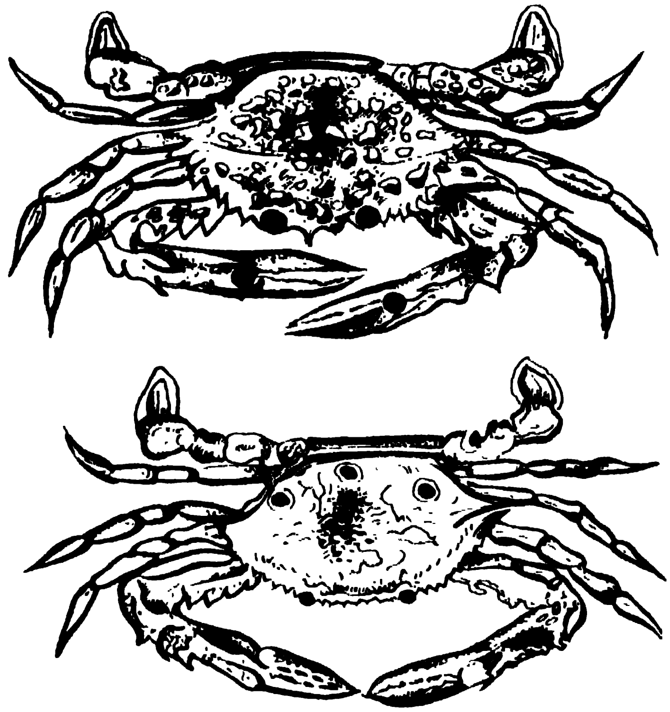

Fig. 1. Some edible Portunid crabs of India. (*top*) *Portunus pelagicus*, (*bottom*) *P. sanguinolentus*

but many can tolerate brackish water; others live entirely in freshwater. A considerable number of them are amphibious—living partly on land and partly in water. Majority of marine crabs live in littoral and shallow waters, but some others live at great depths. A crab has five pairs of legs. In front are the large claws or chelae used for catching food. At the back is a pair of legs sometimes modified to act as fins or paddles for swimming (e. g., Portunid crabs). But the members of the family *Matutinae* have all the four pairs modified to act as paddles. In Portunid crabs, when swimming, one large claw is folded against the body and the other claw is held straight out on the side, away from the direction of the movement, apparently to reduce the resistance of the water. The back paddle-shape appendages move rapidly to propel the crab in sideways movement; which may be very swift when catching a fish or escaping an enemy.

In a claw-to-claw battle, a crab may lose one or more legs, but is able to replace the lost member by regeneration, an ability that is well developed in many invertebrates.

Difference between the sexes

The sex of a crab is found by examining the abdomen or tail folded under the body. It is usually narrow and triangular in the male, fitting tightly under the sternum. The claws of the male are relatively larger than those of the female of the same size. The male sex-openings are situated at the bases of fifth legs. On the contrary, the abdomen of a female crab is broad and round. If the abdomen is lifted up, the large genital openings (vulvae) are clearly visible on the plates of sternum. During spawning the eggs are attached to these swimmeretes by a sticky substance and the female is said to be "in berry".

Life history

The size at which the female crab matures varies species-wise. Most mature females are observed bearing the spongy egg mass on the abdomen from two to nine months after mating. The crabs spawn in deep offshore waters. When spawned, eggs are only about 0.25 mm in diameter and are attached by a sticky substance to the swimmeretes. This sponge-like eggmass may contain from 4,00,000 to 20,00,000 eggs. Its yellow colouring, produced by the yolk of the eggs, changes to black as the yolk is absorbed by the growing larvae.

In summer, following mating, the berried females migrate shorewards to hatch eggs. The newly hatched larvae, called zoeae, are quite different from the parents and are well adapted for swimming in surface waters of the sea. They feed on microscopic plants and animals (planktons) smaller than themselves. Zoeae, like other arthropods, grow by periodic sheddings of their skin. The first three of these moults do not bring about any change in their appearance. After the fourth moult, however, the zoea larva, by a rapid metamorphosis, emerges as a megalopa, which is an intermediate stage between the planktonic zoea and the true crab. It settles at the sea bottom and, after a few days, moults develop into the first young crab. Of the vast number of eggs produced, only one in 10,000 survive disease and predation.

The young crab continues to grow by periodic shedding of its chitinous and limy exoskeleton, several times in the first year. Moulting frequency decreases as the animal becomes larger and older. The females generally moult a little earlier than males. In the beginning of moulting, the crab becomes inactive and seeks shelter amongst rocks or digs and hides into sand. The carapace then splits along the well-defined pleural

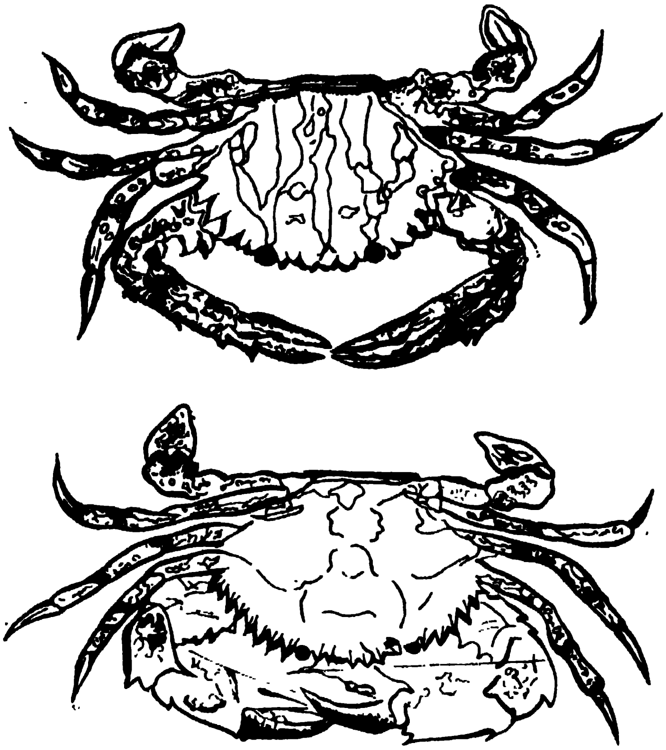

Fig. 2. **Edible crabs**. (*top*) *Scylla serrata* **bottom** *Charybdis cruciata*

line and the soft crab, or peeler, gradually backs out from the gap formed by the partly separated halves of the shell. The crab then absorbs water and increases its volume by as much as 20-30 per cent. The new shell slowly hardens and prevents further increase in size until the next moult. In most crabs, mating occurs when the female sheds her carapace. Two or more days prior to moulting and after, the mature female is attended to by a hard-shelled male which mates with her immediately after the latter has moulted. During mating, the male turns female onto her back and carefully inserts his gonopods (abdominal appendages) into her vulvae. Copulation may last for two to three hours. During this period the sperm-bundles are transferred to the vulvae. The female then secretes a fluid that hardens on contact with seawater and plugs the openings of the vulvae. Sperms so acquired at one mating can remain virile for two or more years and will fertilize subsequent batches of eggs laid by the female.

While crab larvae feed on planktons and adults feed on plant and animal detritus, they are themselves the food of many animals including fishes and man.

Crab fishery in India

Vedvyasa Rao *et al.*, of Central Marine Fisheries Research Institute, Cochin, in a paper presented at the Symposium on living resources of the Seas around India, held at Cochin in 1973, gave a good account of the crab fishery resources in India. Crabs constitute about 4 per cent of the total marine crustaceans (mainly prawns, lobsters, crabs and squilla) landed in India. In state-wise landing of crabs, Tamil Nadu ranks first followed by Kerala, Andhra, West Bengal, Maharashtra, Goa, Orissa, Gujarat and Karnataka. On the basis of the areas from where crabs are caught, crab fishery in India can be classified under three heads—marine, estuarine and brackish water; marine accounting for the major part of the total catch. The estuaries of the rivers Ganges, Mahanadi, Godavari, Krishna, Cauveri and Ennur, the brackish water bodies like Chilka and Pulicat on the east coast, the estuaries of Narmada and Tapti and the brackish waters of Kerala on the west coast are important from the point of view of crab production.

Crabs are caught round the year. However, the peak season for their catch shows a definite seasonal trend in commercially important crab landing areas. On the west coast the peak season is generally from June to December. Vedvyasa Rao *et al.* (1973) estimated the total crab resources 44,000 tons. An exploitation of this resource to the 50 per cent level may not have any harmful effect on the stock and the present annual production can conveniently be increased to about 22,000 tons.

Fishing gears and methods

The economic value of crab, as compared to other fishes and some crustaceans like prawn and lobster, is not high. And, therefore, there are no special gears used for catching crabs. Crabs form an ancillary catch, sometimes in big quantities, in the common gears such as bag nets, boat seines, shore seines, stake nets, cast nets and gill nets used chiefly to catch inshore fishes. Of these bag net, stake net, cast net and boad seine have been described in detail by A. G. R. Sai Sastry (*Fishing for prawns*, *S.R.* March, 1977.

Processing

Though items like crabmeat casserole, deviled crabs, crab cutlet, crab newburg, crab omlette, etc. are popular in the U.S.A., Canada, Japan and other countries, crab has not been given its due place as a food item in our country. Major portion of crab catch in our country is marketed fresh. A small quantity of frozen crabmeat was exported from India in 1965-67. Now since the crabmeat canning has started at Cochin, Calicut, etc., only the canned crabmeat is exported, mainly to U. S. A., France, U. K., Switzerland and Mauritius.

Nutritional and medicinal value of crabmeat

Crabmeat, is low-calorie, high-protein food. Cooked crabmeat contains 77 to 79 per cent moisture, 17 to 20 per cent protein, 1.3 to 1.9 per cent ash, and 0.3 to 1.1 per cent glycogen. Chemical composition depends on the biological condition of the animal and the type of meat. Proteins in crabmeat contain all the important amino acids necessary in human diet. However, there is more tyrosine, histidine, arginine, tryptophane, and cystine, than in fish proteins. Crabmeat, moreover, contains vitamin B_{12}, thiamine, riboflavin, and traces of various mineral elements, viz., sodium, potassium, calcium, magnesium, sulphur, phosphorus, iron, aluminium, zinc, manganese, lead and iodine.

The internal organs contain only 0.9 to 2.4 per cent of oil, except for the liver which has from 6 to 25 per cent, and the roe which has 8 to 10 per cent. The oil from crab liver has a distinctive odour. It is brown (with a green opalescence) in colour, and tends to oxidize (the iodine value is between 161 to 166). Crabmeat is not only tasty and nourishing, but in several countries including India it is believed to have valuable medicinal properties. In Gujarat, Maharashtra and South India crab curry is a reputed cure for asthma. Similarly, soup made from *Scylla* and *Portunus* is used by people just after recovery from malaria, as it is supposed to act as a specific tonic. *Paratelphusa* and other crab soups are believed to cure colds. Some Ayurvedic authorities also recommend crab curries in case of chronic fevers.

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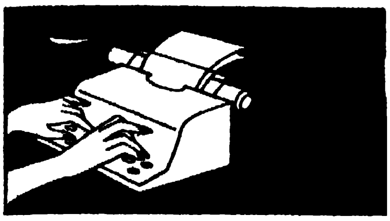

NEWS & NOTES

Symposia on plant sciences

RECENT months saw a spate of botanical symposia in various parts of India. Most of these concerned specialized topics and generated interest among a limited section of plant scientists. The National Symposium on "Recent Researches in Plant Sciences", convened by Professor S. S. Bir at the picturesque campus of Punjabi University, Patiala, on January 20-22 this year, received a keen response and participation from botanists all over India. In choosing a broad theme the organisers, understandably, aimed at bringing together specialists from various disciplines of plant sciences so as to encourage exchange and hybridization of ideas for developing an inter-disciplinary and integrated approach to the challenging research problems. The hosts also utilized this opportunity to arrange their annual series of Dr. A. C. Joshi Memorial Lectures.

During the three days of hectic deliberations, the participants touched upon several fundamental and applied aspects. In the opening Lecture Professor P. N. Mehra highlighted the ecological and structural adaptations of the orchids and called for efforts to protect these "beauties of nature" many of which are facing extinction at our hill resorts. Professor A. K. Sharma, delivering the first Dr. A. C. Joshi Memorial Lecture, explained the changes in structure and behaviour of chromosomes during differentiation which have led him to formulate some new concepts of chromosomal dynamism. A need for 'tilt' towards our own plants in the teaching curriculum was pointed out by Prof. R. P. Roy, who elaborated upon the cytogenetical work done in his laboratory at Patna concerning the monoecism and dioecism in indigenous flowering plants. Dr T. N. Khoshoo demonstrated how hybridization, mutations, polyploidy and tissue culture have been utilized at National Botanic Garden, Lucknow, for the improvement of ornamental plants, a potential source of foreign exchange. Prof. B. M. Johri, of Delhi University, dwelled upon the modern trends in plant taxonomy and suggested suitable changes in curricula and methods of teaching of this important discipline. Besides the Plenary and Special Lectures, nearly fifty research papers were presented in six different sections of the symposium. If the papers presented and the discussions that followed are any indication, it seems that there is an increasing trend towards studies involving functional and experimental approaches. The observational researches are tending to deal with finer details and acquire a distinct taxonomic and systematic slant.

In the concluding session a panel discussion was organized under the chairmanship of Prof. B. M. Johri. The sectional presidents took stock of the progress in teaching and research in their respective fields and made the following recommendations: (1) the educational curriculum should be modernized and an integrated and inter-disciplinary approach should be inculcated among botany students, (2) more attention should be devoted to plants of economic importance, (3) greater stress should be laid on Indian plant material for teaching and research, (4) research on pollen physiology and storage, adventitious rooting and overcoming dormancy should be accelerated, (5) more data on chromosome number of Indian flowering plants should be gathered and greater emphasis should be laid on crop improvement, (6) the services of botany departments of universities and colleges should be availed of, for improvement of urban as well as rural landscape and for plant conservation, (7) single courses should be introduced on viruses, bacteria, fungi and plant pathology with more attention on control of diseases, (8) a synthetic approach is necessary in plant taxonomy and there is an urgent need for study of flora at district level, and (9) there should be more-co-ordination among the Indian Universities to avoid duplication of research work.

The participants agreed that a proper balance should be struck between the fundamental and applied aspects of research. It was also felt that the research laboratories should be more adequately equipped with modern tools and instruments and the scientists should have greater freedom of thought and work so that the problem of brain-drain could be checked.

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Dr. Russell receives Fermi Award

DR. Willian Lawson Russell, an international authority on the genetic effects of radiation in mammals, recently received the $25000 Enrico Fermi Award. The Fermi Award that commemorates Fermi, leader of the group of scientists who achieved the first self-sustained, controlled nuclear chain reaction, is awarded by the U. S. Energy Research and Development Administration, since 1954, in recognition of exceptional scientific and technical achievements in the development, use, or control of atomic energy.

Born in Newhaven, England, on August 19, 1910, Russell graduated from the University of Oxford in 1932. He immigrated to the United States and obtained his Ph. D. degree from the University of Chicago in 1937. He served as a research associate at Jackson Memorial Laboratory (1937-47) and joined Oak Ridge National Laboratory as the Chief Geneticist in 1947. Advisor to the U. S. Delegation to the United Nations Scientific Commission on Radiation since 1964, member of the Board of National Council on Radiation Protection and Measurement since 1965, Dr. Russell was the President of the Genetics Society of America (1965). His areas of research include physiological genetics of melanine pigmentation, genetics of house mouse, relative importance of heredity and prenatal environment and genetic effects of radiation.

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Indian Association of Sedimentologists

NEARLY 75 sedimentologists from all over the country gathered on 26th Dec. 1976 at the Canady Hall of the Aligarh Muslim University to participate in the three day convention of the newly formed Indian Association of Sedimentologists. Prof. A. G. Jhingran is the president of the Association. Prof. V. K. Verma (Delhi) and Dr. V. K. Srivastava (Aligarh) are the secretaries.

Over all 46 research papers were presented which included four key papers presented by Drs. G. R. Udas, A. T. R. Raju, C. Gundu Rao and M. N. Viswanathaih. "A Glance at the Himalaya Sedimentary Frame Work"—the presidential address by, Prof. A. G. Jhingran dealt with various problems related to mighty Himalaya.

It was decided to locate the Head Quarters of Indian Association of Sedimentologists at the Aligarh Muslim University.

RAJ AUDHESH KUMAR SRIVASTAVA
Founder fellow, Indian Association of Sedimentologists, Department of Geology, Banaras Hindu University
Varanasi-221005

VASVIK Research Awards

THE Vividhlaxi Audyogik Samshodhan Vikas Kendra (VASVIK), P. O. Box No. 9037, Patel Vanika, Western Express Highway, Goregaon (East), Bombay-400063 has instituted research awards in order to generate greater consciousness of industrial research in nation development. Six Annual Research Awards of Rs. 25,000/-each and a gold medal will be awarded to the outstanding contributor (s) for the advancement of science, engineering or technology.

The Awards will be given to Indian citizens and Institutions for research in each of the following fields : (a) metallurgical science, (b) pharmaceutical science, (c) electronics, (d) mechanical engineering, (e) electrical engineering, and (f) agriculture.

Those interested are required to submit their applications before 31st May, 1977. Details may be obtained from Shri N. R. Patel, Director, on the above address.

JAUNDICE *(Continued from page 230)*

gress currently to isolate the different products, arising from the photo-oxidation of bilirubin-bound to human skin and explore their action on the activity of the brain. Mor edetriled follow-up studies are also envisaged to locate possiple longterm effects of phototherapy itself on the developing child.

MEDICAL NOTES

Herpes simplex virus, Type 2

WHAT is Herpes Simplex Virus, Type 2(HSV2)?. It is one of a pair of viruses (types 1 and 2) that cause clusters of small, fluid-filled blisters to appear, seemingly without cause, on any part of the body. The outbreak can be extremely painful, may be accompanied by fever, irritability, and fatigue, or it may be only mildly annoying before the symptoms disappear, usually within 12 days. Until recently, HSV2 was considered responsible for genital herpes and skin lesions below the waist, while HSV1, a slightly different strain, caused 'cold sores' and skin lesions above the waist. Now, due to increased orogenital sex activity as well as infection carried from one part of the body to another by the hands, either type may be found on any part of the body. It is possible to have both types at the same time.

How is HSV2 transmitted?

HSV2 is usually transmitted through sexual intercourse. HSV1 is also spread through personal contact, more often oral. Either type may be spread venerally. Once infected, a victim can expect recurrent outbreaks, even though he or she has not been reinfected. The disease can be transmitted only during recurrences, not between times. The herpes simplex virus remains in the body indefinitely, retreating into nerve cells when inactive. A variety of events can trigger an outbreak : sometimes sun, wind, overheated conditions, too tight underwear or pants, fever or sexual intercourse. Some women have a recurrence with every menstrual period. A severe emotional experience often activates the virus. In time, recurrent outbreaks, may become less frequent and less severe.

Medical, dental and nursing personnel may become infected (usually with HSV1), while caring for patients. The virus may also enter the skin through an accidental scrape, or other wound. Many people acquire antibodies to HSV1 early in life and to HSV2 soon after puberty. This does not make them immune to either type, but may protect them from more severe primary or recurrent cases of HSV2. Overcrowding and poor hygiene increase the risk of herpes infection.

How does herpes affect the newborn

A mother with active vaginal or cervical herpetic lesions at the time of delivery can pass on the virus to her newborn. Some 50% of such newborns will be infected as they pass through the birth canal. In silent infection (unseen but detected through Pap smear), the question of transmission to the newborn is still under study. At least 85% of newborns infected will be severely damaged or killed by the disease. Herpetic blisters may appear on the infant's body, eyes and mouth. In severe cases the virus invades such internal organs as the liver, kidneys, brain (encephalitis), or spinal cord (meningitis). HSV2 is usually the cause, but experts estimate that 30% of the cases are due to HSV1. The virus may pass through the placenta, since other related viruses do, but this has not been proven. Women with primary HSV2, frequently have miscarriages, but this could be due to the severity of maternal infection, rather than direct viral attack on the fetus. Infection before birth can occur if the membranes are ruptured for a prolonged period before delivery.

Can herpes infection be prevented in the newborn?

Caeserean section prior to membrane rupture or immediately after (within four hours) is recommended to prevent neonatal herpes if the mother has herpetic lesions in her genital tract at the time of delivery. Only 1 of 16 newborns delivered by caeserean under these conditions became infected, according to recent studies. Women known to have been infected before or during pregnancy must be monitored for recurrent infection as delivery nears. Many infected mothers deliver prematurely.

What is the association between HSV2 and cervical cancer?

Many cancer researchers think that the long-suspected link between sexual intercourse and cervical cancer may be HSV2. Studies have shown that women with cervical HSV2 infection are eight times more likely to develop cervical cancer than those non-infected; about six per cent of infected women show early signs of cancer within five years. Some doctors believe the virus itself may transform cervical cells from normal to cancerous; others say that genetic determinants, other viruses, and the hormonal status of women at risk for cervical cancer are necessary co-factors. Still others suspect that the change results from long term presence of virus particles in incomplete or latent form, but ultimate proof that HSV2 causes cancer is yet to come.

What is the treatment for HSV2 ?

There is no, one consistently effective treatment for genital herpes, and recurrent outbreaks are usually localized and of limited duration. Good genital hygiene and loose fitting undergarments will help, with medication prescribed for relief of severe pain. Prevention, through sexual abstinence when lesions are evident or a recurrence is suspected, is the most successful means of controlling spread of the infection.

While there is no cure for this viral infection, efforts are in progress to find effective treatment for relieving symptoms, shortening duration, and postponing recurrences. Vaccines, dye light therapy, are the two most widely used therapies, though each has its own drawback.

Like all veneral diseases, HSV2 has a combined physical, psychological, and sociological impact. Many physicians recommend family counselling for infected partners to altert them to potential problems during recurrences (possibly painful intercourse, unattractive skin lesions) that may weaken a marriage. Finally, of course the danger of infection in the fetus and newborn is of primary concern.

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Discharge of PCB's into rivers banned in the USA

THE U. S. Environmental Protection Agency (EPA), on January 19, ordered the ban of the direct discharge of polychlorinated biphenyl (PCB), a highly toxic industrial chemical into the U. S. waters. The ban follows recent studies that show that PCB's levels in water and fish exceeded several folds of the standards fixed by the EPA and the Food and Drug Administration (FDA). Widespread use of the chemicals in the past in the production of lubricant additives, hydraulic and compressor fluid, carbonless copy paper, plasticizers, paints and other products has resulted in PCB's being present throughout the environment. Some other studies claim that PBC's cause deformities in fetuses, changes in lever function, nervous disorders and cancers in animals. Widespread in the environment, it is found in almost all major rivers of the world. Significant amounts have also been detected in the air. Although most of these uses have now substantially decreased, PCB's which were discharged into the environment cannot, in most cases, be recovered and will require many years or decades to degrade. This industrial chemical is widely used for insulating electrical equipment, in the recycling of wastepaper and in metal-casting plants. Because of its widespread distribution in the environment and its resistance to biological degradation with a half-life of more than 25 years, PCB's are considered one of the most serious of the many environment contamination problems of today. The FDA has already banned use of the chemicals in the processing of food and feed, where it was sometimes used as cloth and paper insulation in containers and cartons.

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FOR HER

ABC of vitamins

VITAMINS do not give vitality, but they are vital to life. Vitamins are chemical compounds present in foods, and their deficiencies can result in serious diseases, including rickets, scurvy, beri-beri pellagra and night-blindness. A well balanced diet, including the basic four food groups—milk, cereal, vegetables and fruits, and meat always contains adequate amounts of vitamins. Vitamin deficiencies are more likely to occur in infants and children than in adults, and vitamin supplements are routinely used in infants and pregnant women. In general, these compounds are necessary only in trace amounts.

Is there any bad effect of its excess?

Providing an excess of vitamins, more than the recommended daily allowance, has no proven beneficial effect, and may actually be harmful, at least in the case of vitamin A and vitamin D. Contrary to popular notions, there is no evidence that extra vitamins give extra energy, though thousands are sold for this purpose.

During starvation, the harmful effects resulting from protein and calorie malnutrition overshadow those from vitamin deficiencies. However, people who are consuming diets less than 1200 calories should take vitamin supplements, because these diets are deficient in thiamine, niacin and iron. A brief outline of various vitamins follows.

Vitamin A. Vitamin A is present in green, leafy vegetables, yellow vegetables and fruits, tomatoes wholemilk and butter. These items should be eaten 3 to 4 times in a week. Vitamin A deficiency can occur in certain diseases of the liver or intestine. Deficiency of vitamin A results in night blindness and other eye problems. Vitamin A is provided in cod liver oil and in most multivitamin preparations. The recommend allowance is 5,000 units daily. A serious illness can occur from taking an excess of vitamin A. This condition, called hypervitaminosis A, occurs if amounts exceeding 75,000 units are consumed daily. This is a serious illness resulting in nervous system disease, vomiting and bone disease. It can be reversed by stopping the vitamins.

Vitamin B. The vitamin B complex is a group of vitamins which occur in a wide variety of foods, and deficiencies often occur together. Deficiencies of vitamin B complex occur in people with very poor nutritional habits, or in alcoholics who eat poorly. Vitamin B_1 or thiamine, is present in many foods, including meat, eggs, vegetables, breads and cereals. Deficiency of thiamine, called beri-beri, occurred in widespread areas of South-East Asia where the diet consisted largely of polished rice. Thiamine deficiency causes severe illness with neuritis, weakness and pain in the legs, severe weight loss and heart trouble. Thiamine should be taken by people on low calorie diets, and by alcoholics.

Riboflavin, another B complex vitamin, is also present in a wide variety of foods. Deficiencies are associated with cracking of the skin at the angles of the mouth and in the tongue. Deficiency of this vitamin seldom occurs without deficiencies of the other B complex vitamins.

Niacin, or nicotinic acid, is an important vitamin. Pellagra, a disease which was widespread in the South-Eastern United States before 1940, was due to a deficiency of this vitamin. It occurred in people whose diet consisted mainly of maize or cornmeal. This disease is characterized by severe dermatitis, diarrhoea and mental abnormalities. It is easily prevented by standard, well rounded diet.

Vitamin B_6, or pyridoxine, rarely causes a deficiency in man, but pyridoxine supplements should be taken when certain antituberculous medications are used, in order to counteract a tendency for neuritis.

Vitamin B_{12}, deficiency occurs in pernicious anemia and in certain diseases involving the small intestine. This vitamin occurs in many foods, and a deficiency results only if the body cannot absorb it. If needed, it can be provided by monthly injections.

Vitamin C. Vitamin C or ascorbic acid became famous in the 18th century when it was found that sailors developed a serious disease called scurvy after they had been at sea for 4 or 5 months. An English physician found that this disease could be prevented by the use of citrus fruits, or lime juice, leading to the term 'Limeys' for English sailors. Scurvy is characterized by swollen, bleeding gums, bleeding of the skin, and bone problems. Occasionally vitamin C deficiency occurs in an individual living alone as a hermit or recluse, existing on a diet of starches and package foods, without any vegetables or fruits. It can be produced in normal individuals by depriving them of vitamin C for about 140 days. It can be prevented by the intake of about 50 milligrams of vitamin C daily, the amount present in a 4 ounce glass of orange juice. It is also found in tomatoes and many vegetables. Recently there has been widespread publicity about the use of vitamin C to prevent or treat colds. Thus far there has been no proof that this works, but extra vitamin C causes no apparent harmful effects, and the excess vitamin C is excreted in the urine.

Vitamin D. Vitamin D is present in milk, fish, oils and in the skin after exposure to sunlight. About 400 units are necessary daily to prevent rickets in a growing child. This amount is present in one quart of enriched milk. Vitamin D deficiency causes rickets in children, and other types of bone diseases in adults. Occasionally this deficiency occurs in an adult who has intestinal abnormalities and cannot absorb vitamin D from his food. An excess of vitamin D causes a serious illness with excessive calcium in the blood, leading to headache, nausea, vomiting, kidney stones, and possibly permanent kidney damage. As little as 2,000 units daily can produce this toxic reaction in children, and amounts over 50,000 units daily can produce it in adults. Therefore, excess use of Vitamin D must be carefully avoided. When large amounts of vitamin D are used to treat certain rare metabolic diseases, close monitoring by a physician is necessary.

Vitamin E. Vitamin E has received wide publicity recently, and has been claimed to prevent skin disease, warts, ulcers, strabisums, baldness, frostbite, arthritis, jaundice, muscular dystrophy, diabetes, liver trouble, thyroid trouble, sexual impotence, aging and heart disease. In addition, it has even been alleged to be an antidote for air pollution. There is no well defined vitamin E deficiency state in adults, because the amount needed is adequately supplied in the usual diet. Vitamin E is present in many common foods, including vegetable oils, vegetable shortening, leafy vegetables and whole grain. It is also found in cow's milk.

It would probably take more than 40 years of a vitamin E deficient diet to deplete an adult who had previously been on a normal diet. Only in small, premature infants has there been convincing evidence of a real deficiency. These infants weigh less than 2.25 kg and are given artificial formulas. The claims that large doses of vitamin E are beneficial in the treatment of any abnormal adult condition are unfounded. Numerous studies have failed to indicate that vitamin E is useful in treating or preventing heart disease. Other claims have suggested that large doses of vitamin E can improve athletic performance, but controlled experiments have not supported these claims. Though a large number of people are taking large doses of vitamin E, it appears that serious adverse effects are rare. Occasionally diarrhoea and intestinal cramps have been reported with doses over 3,000 units daily.

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SODIUM (*Continued from page* 233)

Distillers in U.S. and I C I in U. K.

Sodium demand is rising slowly with the growth of the conventional sodium using industries, and further increased demands can only come from nuclear power plants employing sodium as a coolant.

Further reading

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SCIENCE FOR THE YOUNG

Sun, earth and the atmosphere

AIR, water and solar energy sustain life on earth. At the dawn of human civilization, men believed in supernatural powers and prayed for protection. Today, we know that the sun is the principal source of energy for all physical processes in the atmosphere—winds, rain, season and climate.

Sun and earth

Out in the interplanetary space the sun may be a dwarf, but it is the single noteworthy source of energy for the earth-atmosphere system. The sun is about 149.6×10^9m away from the earth. This distance changes during the course of the year. As the earth revolves round the sun in an elliptical orbit, changes in seasons take place. Earth also rotate around its own axis which is tilted to plane of its revolution around the sun at an angle of 23½°. So northern and southern hemispheres follow different seasonal cycles. January is winter and July is summer in the northern hemisphere; the reverse is true in the southern hemisphere. The sun consists mainly of three parts, the photosphere, the chromosphere and the solar corona. Photosphere is the visible disc. Surrounding the photosphere is chromosphere which comprises mainly of thin gaseous matter. Beyond the chromosphere is the corona—the pearly veil of extremely hot gases. Chromosphere and corona are visible with the help of instruments or when the photosphere is shadowed during an eclipse. The sun emits a vast range of waves ranging from cosmic rays, X-rays down to radio waves, 15m or more in wavelength. The estimated temperature of the sun is about 7300° K. The radiation seen by human eyes is the visible part of the solar spectrum. Waves shorter than this are called ultraviolet and larger ones are called infrared.

Most of the energy emitted by the sun is wasted as it passes out into the space in all directions. A very small part of the solar output (1/2,000,000,000 part) is intercepted by the earth. Yet it is an enormous amount by earthly standards. The earth receives nearly the same energy per minute as is consumed by mankind in one year ! Almost all processes of plant and animal life, weather and climate and other geophysical phenomena are dependent on the solar energy.

We all know that the earth is surrounded by a gaseous envelope called atmosphere. It consists mainly of nitrogen, oxygen, carbon dioxide, and inert gases like argon, neon, xenon and radon. Other gases like ozone and hydrogen are present in very small amounts. The atmosphere plays an important role in the redistribution of the solar energy and its manifestation as weather and climate. At the top of the atmosphere 1.94 cal. of heat is on an average received per minute over an area of 1 sq. cm. So over the globe the average solar energy received per year is 263 Kilolangleys (1 Langley = 1 gm. cal/cm²).

Green house effect

The sun is therefore largest source of energy above the earth. Compared

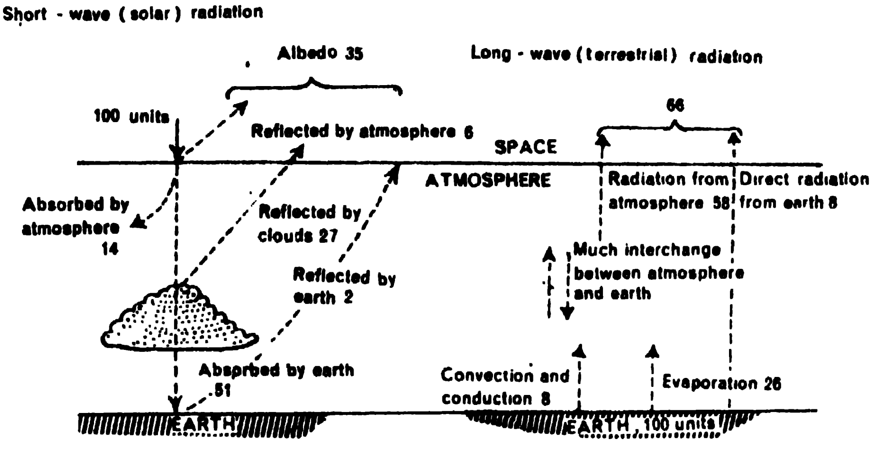
Short - wave (solar) radiation
Albedo 35
Long - wave (terrestrial) radiation
100 units
Reflected by atmosphere 6
66
SPACE
ATMOSPHERE
Radiation from atmosphere 58
Direct radiation from earth 8
Absorbed by atmosphere 14
Reflected by clouds 27
Reflected by earth 2
Much interchange between atmosphere and earth
Absorbed by earth 51
Convection and conduction 8
Evaporation 26
EARTH
EARTH , 100 units

Fig. 1. Radiation target of the earth and atmosphere

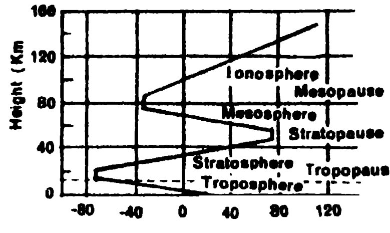

Fig. 2. Vertical variation of temperature in the atmosphere

to this, energy released by an atomic or hydrogen bomb is insignificant. About 1/3rd of the solar radiation is reflected back to space by the earth or by the clouds. Some of the radiation is absorbed by atmosphere, cloud, etc., but it is usually small. Air molecules and particles of dust scatter a part of solar radiation. The sky appears blue because of the scattering. Ozone which is present in the atmosphere mainly in a layer at an altitude of 20-30 kilometre absorbs the powerful ultraviolet radiation. The remaining energy reaches the surface of the earth, which is partly reflected and partly absorbed. The reflection is very high over snow-covered areas and is very low over oceans. The heat absorbed by the earth raises its temperature, evaporates water from lakes and oceans, and heats up the atmosphere from below. Like the sun the earth also sends out radiations but they are not visible to human eyes. These long wave terrestrial radiations are mostly absorbed by clouds, water vapour and carbon dioxide. The atmosphere which allows solar radiation to pass through does not allow much of the terrestrial radiation to escape into the space. This phenomenon due to which the earth retains heat is called the "Green house effect".

Anatomy of atmosphere

The atmosphere is heated by the earth's surface which absorbs most of the solar heat. From the ground as we go upwards the temperature decreases. The rate of cooling is called "The Lapse rate" and is of the order of 5°-6°C/km. This fall in temperature is confined to the lower part of the atmosphere called troposphere.

Most weather phenomena originate in the troposphere. Above the troposphere lies the stratosphere. It is a layer of atmosphere in which a uniform temperature persists. The boundary between the troposphere and the stratosphere is called the tropopause. The height of the tropopause is maximum near the equator and minimum over the poles. Above the stratosphere (about 30 km or so) temperature again increases with height and is maximum at an altitude of about 50 km. From 60 km upwards the atmosphere is characterised by the presence of charged ions of various gases. It is known as the ionosphere—a region of ions. Ultraviolet rays and X-rays from the sun are mainly responsible for ionising the air and creating the ionosphere. Throughout the ionosphere, temperature is believed to increase with height and by about an altitude of 100 km or so it may be as warm as the air at the sea level. The electrically conducting ionosphere surrounds the earth like a giant umbrella and mirrors back the radio waves making long range radio transmission between distant places possible.

Importance of oceans

Nearly three-fourths of the globe is covered with oceans and seas. Oceanic soundings have proved that the sea floor is more irregular than usually thought and sharp ridges and trenches occur side by side. The average depth of the ocean floor is about 3800 m which is about hundred times more than the mean height (245m) of the land areas. The ocean water, whose volume is about 350 million cubic miles, is a rich source of dissolved compounds and elements. It fosters marine organism of abundant variety. The land and ocean react differently to solar heating and its interaction with the atmosphere produces the cycle of weather and climate.

Climate and weather

It is noticed that the equatorial region absorbs more heat than they loose and the polar regions radiate more heat than they receive.

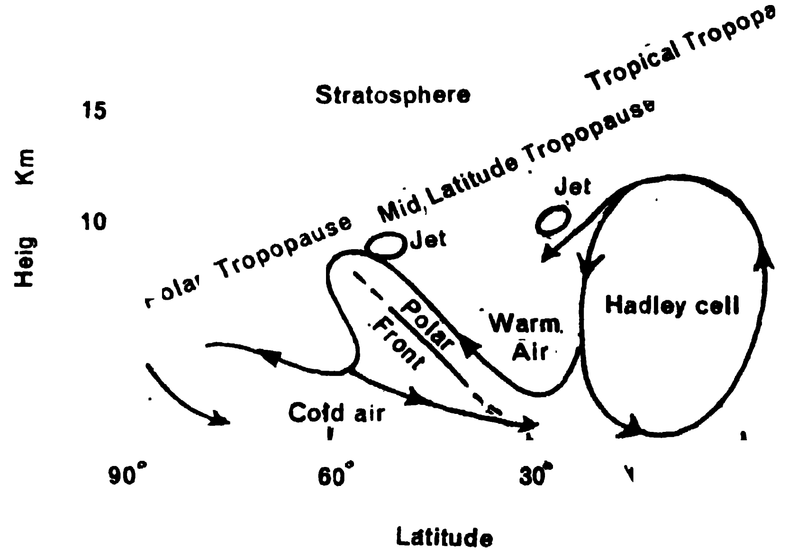

Fig. 3. Three-cell atmospheric circulation model

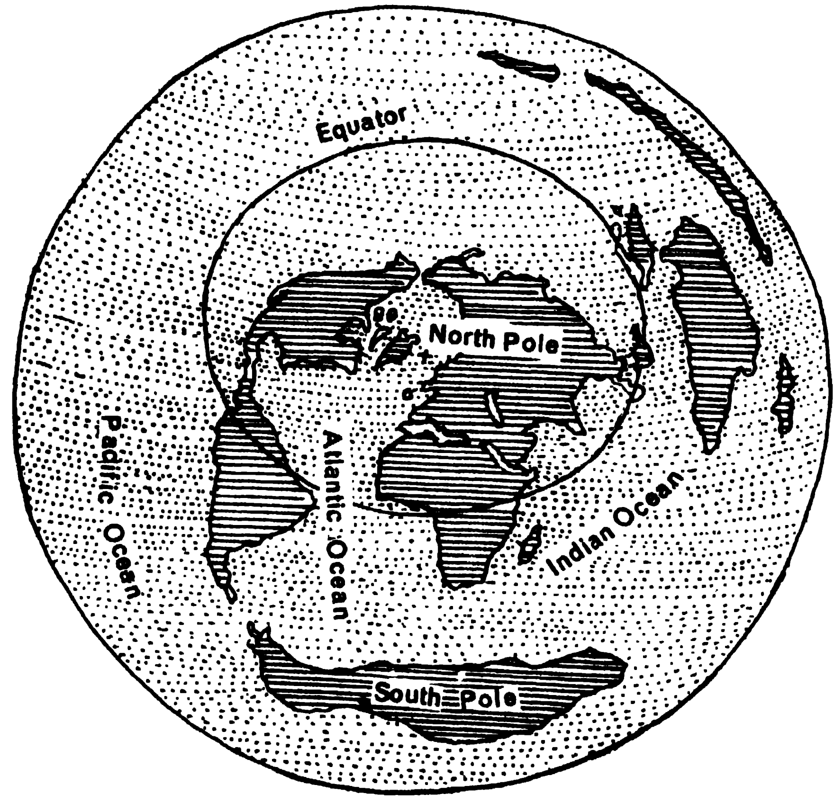

Fig. 4. Land and ocean on the earth

Nevertheless the equatorial belt does not become progressively warmer nor do the poles become colder because an exchange of heat is brought about by movement of air on atmosphere and upper layers of water in the oceans. This process is known as circulation. In the tropics, warm air rises and spreads poleward and sinks over the sub-tropical anti-cyclones of both the hemispheres. At the lower levels, there are "Trades" flowing westwards and equatorwards over the tropics.

In the sub-tropics there are the subsiding warm air and cloudless sky of the deserts. In the middle latitudes are present the west winds. Lastly, the polar regions with the high radiation loss have usually subsiding easterly winds. This simple picture, perhaps too much utopian, is not the same every day. Weather systems like storms and depressions, local topography, seasonal changes in radiation balance and land and sea distribution over the earth—all react differently to modify this ideal picture.

Weather forecasting

These variations are the sauce of atmospheric life and make climate different from weather. A forecaster aims at understanding the future moods of atmosphere from its present state. Observations from different parts of the globe are required for making an accurate picture of the present state of the atmosphere. With the progress of science and technology new tools such as weather radars, rockets and satellites have been pressed into the job of observing the atmosphere extensively and carefully. The weatherman relies mostly upon the physical laws of the earth-atmosphere system and his experiences to get the correct answer.

Numerical weather prediction

The earth's atmosphere is a fluid in motion. Air contains a variable amount of water vapour and forms a thermodynamic system. Changes of weather are results of air motions and thermodynamical changes in water substances in response to certain forces acting on the system. It is theoretically possible to predict the future state of the atmosphere by knowing the initial state and the set of mathematical equations governing the dynamical behaviour of the atmosphere. Though possibility of such forecasts was suggested in early twenties by the British meteorologist L. F. Richardson, it remained a dream until the advent of fast electronic computers. It is nowadays possible to produce these forecasts by the numerical solutions of the governing equations. This method is known as the Numerical Weather Prediction (NWP). However, for providing better forecasts, research and refinements are necessary to catch the complexities of nature in more realistic details.

GARP

To get a better understanding of the atmospheric processes a project called GARP (Global Atmospheric Research Project) is under way. This project has been jointly sponsored by the World Meteorological Organisation (WMO) and the International Council of Scientific Unions (ICSU). Under the aegis of this global venture, atmosphere will be observed more closely, simulated more realistically by models and probed in to know the hitherto unexplored regions. The obtained observations will engage the attention of several teams of scientists all over the world for several years. Operations on several sub-projects of GARP are already in progress. The final outcome will surely improve our understanding of weather, climate and its prediction.

Further reading

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Methods of multiplication

DISCUSSED below are different methods of multiplication.

Method I. Suppose we want the product of 16 and 23. The ordinary multiplication with which we are acquainted is as shown in Fig. 1. There is no need to explain this method.

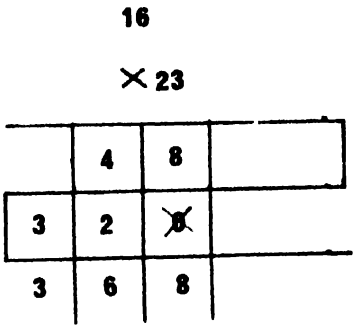

Fig. 1

Method II. To explain this method we again take the numbers 16 and 23. We write 16 and 23 as shown in Fig. 2 (a) Multiply 2 with 6 and write down 12 as shown in Fig. 2 (b). Next we take product of 1 and 2 and write down 02 as shown in Fig. 2(c). Similarly we write the products of 3 and 6 (=18) and 3 and 1 (=03) as shown in Fig. 2(c). Add the numbers of Fig. 2(c) along the arrows shown. So the required product is 0368=368.

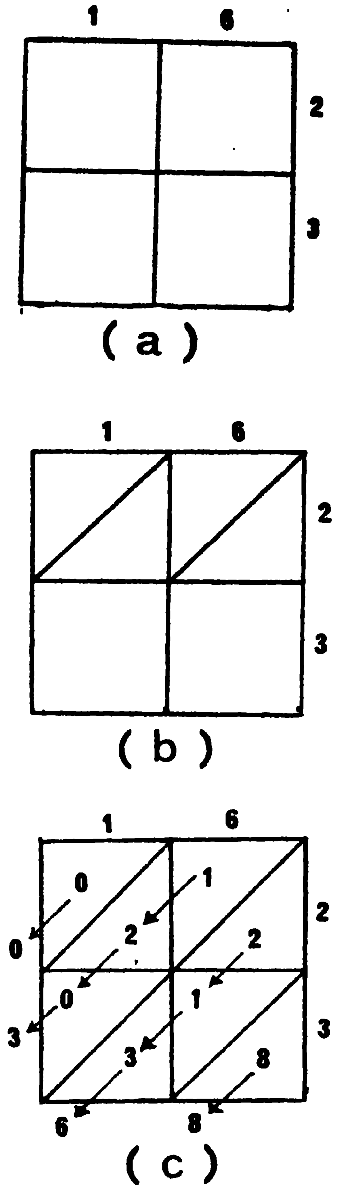

Fig. 2

Method III. To illustrate this method we take the numbers 16 and 23. Here we form two columns, column I and column II, as shown in Fig. 3. In column I, we write down 16 and in column II we write down 23. Now in column I write double of 16, i. e., 32, just below 16 and so on. In column II write half of 23, i. e., 11½, just below 23. Since 11½ is not an integer, we write down 11. Repeat the process till we get 1 in column II. Pick out the even integers of column II and cancel the corresponding numbers in column I. In this case cancel 128 of column I, as it is corresponding to the even integer 2 of column II. Now add the remaining numbers of column I, we get the required product, i. e., 368.

Method IV. In this method we write the numbers from one to nine as shown below :

From the numbers one to five there is no change, i. e., 1=1, 2=2, 3=3, 4=4, 5=5. For 6, we write 0—4. Here we denote—4 by an inverted 4, i. e.,—4=ㄣ.

∴ 6=10—4=1ㄣ

Denote—3 by Ɛ,

∴ 7=10—3=1Ɛ. Similarly

8=10—2=1ᘔ

9=10—1=1ı

Now as an example we take the product of 16 with 23. Here

COLUMN I	COLUMN II
16	23
32	11
64	5
128	2
256	1

368

Fig. 3

16=20—4=2ᔭ

So we want 2ᔭ × 23.

Step I : Multiply 3 with ᔭ. Thus

3 × ᔭ=3 × (—4)=—12=ıᄅ

Write down ᄅ as shown in Fig. 4 and carry on ı

Step II : Take the product of 3 and 2.

3×2=6=10—4=1ᔭ

To 1ᔭ , we add ı which we have carried on from Step I.

∴ 1ᔭ+ı=10—4—1=5;

Put down this 5 to the left of ᄅ as shown in Fig. 4.

Step III : Take the product of 2 and ᔭ

2 × ᔭ=2 × (—4)=—8.

=—(10—2)=—10+2

=ı2

put down 2 as shown in Fig. 4 and carry on ı .

Step IV : Take the product of 2 and 2 (=4) and add to it ı of the Step III. So we get 4+ı=4−1=3. Put down this 3 to the left of 2 as shown in Fig. 4.

Explanation (The sum of 5ᄅ and 32).

ᄅ+0=ᄅ.

As 5+2=7=1Ɛ , put down Ɛ and carry on 1.

∴ 3+1=4. Thus we get the required product

16×23=4 3 2

=400 − 30 − 2

=368.

	2ᔭ ×23		
	5	ᄅ	STEPS I AND II ←
3	2	X	STEPS III AND IV ←
4	Ɛ	ᄅ	SUM OF 5ᄅ AND 320 ←

Fig. 4

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How an electric line tester works

YOU have surely seen an electrical line (voltage) tester, a screw driver-like device, used by electricians while trying to detect a fault in an electrical wiring system in a building or electric circuit. The line tester is generally employed to locate which components of the circuit or plugs, sockets and switches, etc., in electrical installation under test are 'live' when current supplies are switched on. You must also have noticed that a part of tester lights up with orange-red colour when its tip (other end being earthed by thumb) touches the 'live' wire. If the wire is not 'live' the tester does not light up. Though everyone has seen the electrician using the tester in this way, very few know how it actually works.

Most of the electricity supplied to the home, industrial or public sector is in the form of an alternating current (A.C.). Unlike D. C. (Unidirectional direct current), in the case of A. C. both current and voltage vary continuously with time along a sine curve (Fig.1). Starting at 0, both of them reach a positive maximum A in one direction during positive phase or half cycle of A.C. Then they fall back, pass through zero at B and reach maximum C in opposite direction and, then, rise again to reach zero at D during the next half cycle or negative phase of A. C. In India, this cycle repeats itself at the rate called frequency of A. C. mains, 50 times per second (50Hz). This means that the current flows back and forth in the supply wires 50 times every second. As a result, the voltage of the line wire or phase fluctuates up and down in accordance with the current alternations in mains supply at this rate.

A.C. is produced at the main power station by three-phase alternators based on the principle of rotating magnetic field. The current is induced in three pairs of coils by rotating a 'field coil' (the coil that carries a current to produce a magnetic field) between these pairs of coils. The current in a pair of coils varies with time depending on the position of the field coil. In practice, the electricity generated at main power station through the grid or distribution networks (transformer units) is split into single-phase locally to the consumer or an estate of houses. They might be wired up to one street or group of houses receiving one phase, while the next street receiving another phase.

The current in each single-phase installation is carried away by its own pair of conducting wires called the 'line or live or phase' and the 'neutral'. They are also provided with an 'earth wire' for safety. The

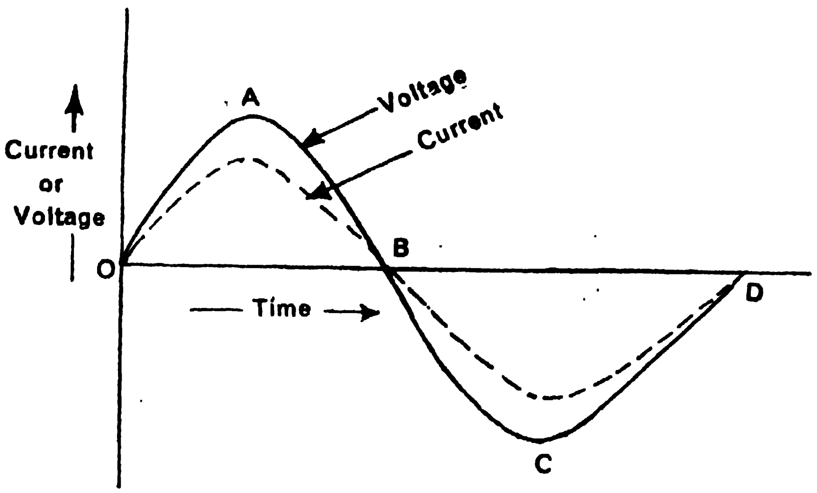

Fig. 1. Sinusoidal variation of current and voltage in A.C.

'neutral' is normally held at a steady voltage nearly the same as earth (zero potential). The 'earth' is a long thick metallic conducting wire generally galvanised iron (copper was used earlier), inserted deep into the ground. When the connecion in an electric circuit of wiring system is faulty, a leak of electricity is likely to occur. Such an electrical leakage, called 'short circuit', is quite dangerous as it may cause fire or damage to the circuit. To prevent this, 'earthing' is provided so that electricity leakage, if any, is carried away by the earthed conductor. In India, the local mains at the consumer are single phase three-wire system (the phase, neutral and the earth) operating at 220 volts phase-to-neutral, i. e., tne voltage difference between the phase or line wire and the neutral is 220 volts.

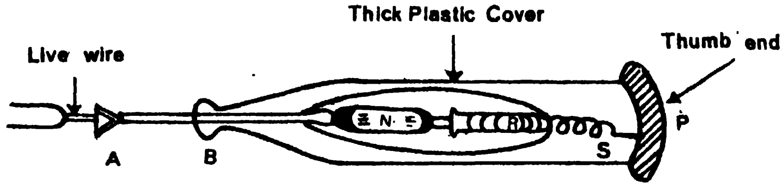

Fig. 2. Line tester with neon tube

The line tester consists of a sharp, chisel-headed metallic rod AB connected to the stem NP that is covered by a very thick-non-conducting transparent plastic coating. The stem contains a small neon tube N and a high resistance R of about 1 megaohm (10^6 ohms) connected by a conducting spring S (Fig. 2). The other end of the resistance is also connected to an earth connection end P. This is a conducting metal piece P which is held at zero voltage (earthed) by covering it with the thumb at the time of line testing. The resistance of the human body is about 20-30 kilo-ohms and the fleshy tissues of the thumb in contact with the metallic piece P act as a conductor to electricity. Greater danger of short circuiting across two terminals of electrical mains, equipment or circuit at different voltages is likely to occur when whole body of tester rod is exposed. To prevent this, only the tip A of the metallic rod is kept exposed and the rest of its body is covered by an insulating plastic cover.

The neon tube consists of a pair of cylinderical metallic electrodes, separated by a small gap, sealed within a glass tube. The tube is completely evacuated of air and is filled with neon gas at a low pressure. The neon gas (inert) in this gap offers a high electrical resistance to current and so acts as an electrical insulator due to absence of conducting ions thereby preventing the flow of current. When a sufficient voltage difference is applied across the electrodes, it is sufficient to overcome the resistance of the gap. As a result, neon gas starts conducting electricity.

As the electric current flows through the neon gas, the electrons are knocked off from outermost quantum orbits of the neon gas atoms, leaving the resulting ion with a positive charge. Further, these electrons moving with high enough velocities collide with gas atoms and ionise the gas more and more. Thus the neon atoms breakdown into two electrically charged components, viz., the positively charged ion and the negatively charged electrons, i.e., the gas is ionised. The charged particles are capable of carrying an electric current. Consequently, the neon gas that is normally an electrical insulator becomes a conductor. The neon atoms are now excited and so cause the neon gas to glow at both electrodes in A.C. and at single electrode in case of D. C. with a bright orange red colour. The intensity of this light depends on the voltage; the greater the voltage the more intense is the glow. However, the voltage at which this happens also depends on the size of the gap or separation between the electrodes.

As soon as the neon gas conducts electricity, it lights up. Consequently, the voltage difference that is otherwise required to push the current though the gas suddenly drops. This results in considerable increase in current inside the neon tube. To avoid any possible accident or damage due to this large flow of current, the megaohm carbon resistance R is introduced between the neon tube and the earth connection (thumb end) of the tester. This high resistance in the tester limits the flow of current once the neon tube starts glowing. It may be remembered that 'live' electric circuits should be probed only by the line tester. It is dangerous to test them with an ordinary screwdriver.

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Do it at your home

Germanium radio

IN this issue, how a little electronic toy can be made is discussed. Made with a little care, this germanium radio will work excellently for a long time. The circuit of the radio is given in Fig. 1. Each component of the circuit is discussed below.

Antenna-Ant This should be, ideally speaking, a high wire stretched well above the ground and insulated from it. A clothesline does quite well provided the nails at either end are driven into wood. It is, advisable not to use long clotheslines stretched high above the ground (one on a terrace, for example) because the volume of the radio may become too loud for listening. If a clothesline is not available, use a telescopic antenna or the metallic portion of a table-lamp (do not use the socket).

Choke L : This is an important part of the radio circuit and so must be made neatly and carefully. The coil is made by winding about 40 turns of n. 22 enamelled copper wire onto a ferrite rod about 7.5 cm long. The enamel must be scraped off the wire at the ends of the coil.

Earth Gnd: Hold this end tightly in your fingers, or, still better, tie it to a water pipe. If the pipe is rusty or dusty, sandpaper it, till the shining metal is revealed; then solder the ground wire here.

Condenser C: Use 550 pf. variable condenser (ganged or single). If you fail to get a single, then use only the central terminal and one end of the ganged condenser.

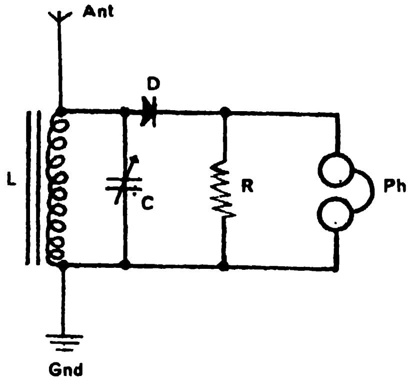
Diode D : Use a SD46 or OA81 diode. Some other diodes could also be used, but often they do not give good response.

Resistor R: This is a 1/8 watt 220 Kohm resistor.

Headphones Ph: This is another important portion of the circuit. The best items for this portion are a pair of high-quality headphones usually available from ex-army stock. It is better not to go in for the hearing-aid type earphones, because they have, apart from a low efficiency, a very bad frequency response and high distortion. These headphones, on the other hand, are usually, qualitatively almost at par with the stereo headphones commercially available.

Fitting up the circuit

It is best if you can mount the whole thing on a printed circuit board, though a cardboard piece serves equally well. Inventive readers may try putting the whole circuit, including the telescopic antenna, on to the headphones.



Germanium Radio

Fig. 1

Coil : Rc 1
Condenser : Rs 2.50
Diode : Re 1
Resistor : Rc 0.20
Headphones : Rs 18 (For high quality ones; others are cheaper)

Total 22.70

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Science oddities

STARS are made up of extremely hot gases, and hence it may seem to us that they must be very light indeed. But this is not always true. Paradoxical as it may seem, some of the smallest stars are extremely heavy. A cubic centimeter of material from these 'white dwarfs' as they are called, would weigh a tonne or more if brought to earth. For instance, the white dwarf, Van Maanen's star, is so dense that a spoonful of it weighs 7¼ tons. The largest stars are the least dense. In the red giant star Antares, the gases are so rarefied that our atmospheric air is 3000 times denser.

◆ ◆ ◆

A tree that actually murders its host is a strangler fig found in the jungles of Brazil. It starts life as an epiphyte—a harmless lodger. Sprouting high on the branches, it soon sends down roots, some of which reach the soil, while others completely cover the trunk of the host. It is this network of hardening roots that actually squeeze the life out of the host. By the time the victim is dead, the killer has usually grown so much that there are no visible traces of the supporting tree and the mature strangler, now independent, may grow to an enormous size.

◆ ◆ ◆

A river of air moving at great speed, which helps planes to fly faster sounds like science fiction, but such a stream of air does exist, high up in the atmosphere, 13 km above the earth. This wind current, moving at speeds of 100-400 kmph. is appropriately called the jet stream. It was discovered accidencally during World War II by airtraft crew who encountered west winds of such high velocity that they sometimes found themselves flying backwards! Investigations on this strange phenomenon revealed possibilities of its actually helping eastbound planes by saving time and fuel.

◆ ◆ ◆

"HARD as steels" and "fragile as glass" are expressions which are well on their way out. For all steel is not hard, nor is all glass fragile. In fact, a new toughened variety of glass, recently developed, is six times harder than ordinary steel; on the other hand, during tempering of steel to harden it, if instead of heating the steel and cooling it gradually, the hot steel is suddenly cooled, it becomes as fragile as ordinary glass.

◆ ◆ ◆

INSECTS may look small and fragile, but they have enormous strength. In fact, we cannot match the performance of these little 'giants'. A tiny ant can carry a load 50 times its own weight. A bee can do better—it can haul 300 times its weight. But the champion weight lifter is the beetle, which can support 800 times its own weight. To match this performance, a man weighing 70 kg would have to lift about 60 tons.

◆ ◆ ◆

IT seems unbelievable that there was time when the mighty Himalayas with the Everest rising higher than any other peak in the world, were not there al all. Yet it is true. During its long evolution, in a kind of cyclic rhythm the earth has, from time to time, thrust up new mountian ranges and high plateaux, which were then weathered and washed away by the forces of erosion. A new cycle of mounting formation then started all over again. Like most of the major mountain ranges today, such as the Andes, the Rockies and the Alps, the Himalayas are comparatively young mountains—being only about 50 million years old.

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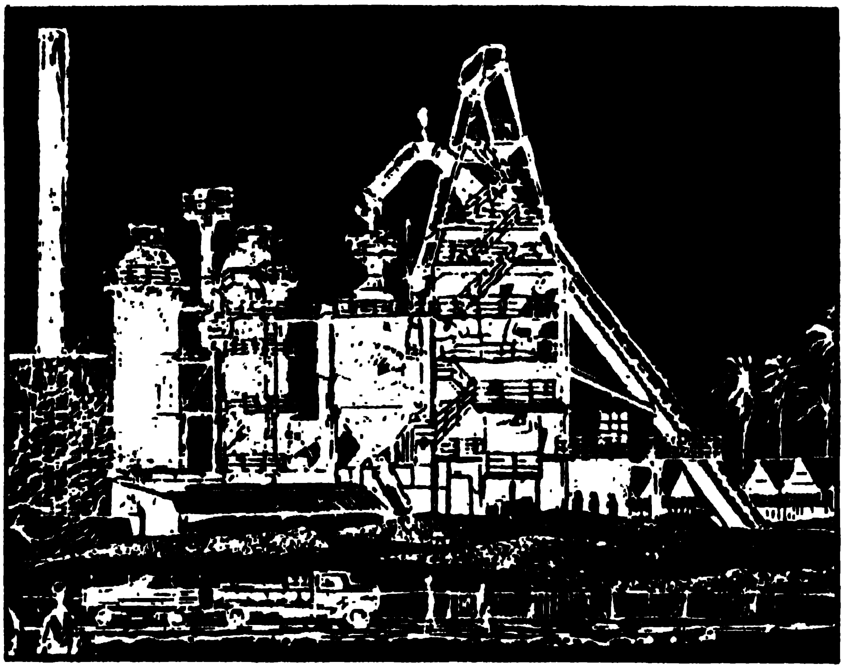

SCIENCE IN INDUSTRY

Recent drugs developed in India

AN important objective of the Central Drug Research Institute, Lucknow is to provide assistance to the pharmaceutical industry in strengthening its technological base, helping it to achieve self-sufficiency in production of essential drugs and their intermediates, and reducing dependence on foreign collaboration for new drugs or new technology. Development of know-how for products identified by industry is undertaken as sponsored projects or as collaborative projects.

Some of the projects completed in recent years and the know-how passed on to industry are given below.

Indomethacin

It is a well-known anti-inflammatory drug widely used for treatment of arthritic conditions. At present it is being imported through State Trading Corpn. and formulated by Indian Drugs and Pharmaceuticals Ltd., in a crash programme to meet the country's demand. Know-how has been developed by CDRI in close collaboration with two sponsoring firms, including the IDPL, which are shortly undertaking its production. The process is three-step starting from indigenously available para-anisidine. Indigenous production will result in considerable import substitution as the value of import in 1973-74 was Rs. 30 lakhs.

Ephedrine

It is a widely used bronchodilator and nasal decongestant. Formerly the drug was made from the Ephedra plant, but sufficient quantity of the raw material is not available indigenously for economic production. At present the demand is met by import and limited production from an imported intermediate 1-acetylphenylcarbinol. Indigenous production in 1973-74 from imported intermediate worth Rs. 9 lakhs and import was to the extent of Rs. 27 lakhs. Estimated demand in 1978-79 is 50 tonnes. In close collaboration with the sponsoring firm a process has been developed which is based on production of the intermediate by microbiological conversion of benzaldehyde with a suitable strain of yeast, and conversion of the intermediate by a synthetic method to l-ephedrine. Except for benzaldehyde all the other raw materials are produced in the country. Benzaldehyde of the requisite purity is likely to become available in the near future. The sponsor has commenced production of the intermediate very recently.

Amitriptyline

This is a widely used anti-depressant, and was imported to the value of Rs. 13 lakhs in 1973-74. A process for its manufacture which is entirely different from methods used in other country was developed. The process has been successfully scaled up by the sponsor who has undertaken its commercial production.

Another useful drug which has gone into production with CDRI know-how is the analgesic *D-propoxyphene*. It has the advantage of being non-addicting and without anti-pyretic action. The developed process involves sophisticated technology involved in a separation of isomers.

L-Dopa

It is a valuable drug for treatment of Parkinson's disease which causes uncontrollable tremors of the limbs. A simple process has been standardised for its extraction from the beans of *Mucuna prurita*, known in Hindi as 'Kiwanch' which grows wild in the country and for which there is no economic use. The cost of production, according to the process developed, compares favourably with the imported drug. Its import was of the order of Rs. 6 lakhs in 1973 and estimated demand for 1978-79 is Rs. 56 lakhs. The process has been handed over to a firm for commercial production.

Dimethylbenzimidazole

It is a key intermediate required for the production of vitamin B_{12} and is at present imported. In collaboration with a technical entrepreneur, technology for its production has been developed; the only imported raw material being 3, 4-xylidine. The entrepreneur has recently commenced production to meet the indigenous requirements of vitamin B_{12} manufacturers.

Pepsin

This is an enzyme used for various purposes and is imported to the value of Rs. 8 lakhs to meet the country's needs. A process has been developed for its production from stomach of goats which is a waste product of slaughter houses. The process has been handed over to a technical entrepreneur through the National Research Development Corporation.

8-Hydroxyquinoline

It is an important drug intermediate mainly used for the production of drugs for treatment of amoebic dysentery. Its production in the country is insignificant and the projected demand for 1978-79 is 450 tonnes. A process for its production from quinoline through sulfonation and alkali fusion of the sulfonic acid has been standardised. A pilot plant has been erected to scale up the process to semi-commercial scale.

A major area of work of CDRI is the development of new and better drugs for various diseases.

The first new drug discovered by the Institute is an anti-thyroid agent which is useful for the treatment of hyperthyroidism. The new drug, named, Centimizone, is useful in cases that are refractory to the presently available drugs like neomercazole and potassium chlorate. The drug control authorities have granted approval for marketing and it will be put on the market soon by a pharmaceutical firm.

Certain other drugs are in the final stages of development. One of the most promising is a local anaesthetic which has been successful in clinical trials for infiltration anaesthesia, nerve-block and ophthalmic anaesthesia. A new antifilarial drug is five times as potent as the presently used diethylcarbamazine in killing the microfilaria and is much safer in Phase I clinical trial. Trials in human patients will be undertaken shortly. Similarly, another compound has been found effective in eliminating tapeworms in experimental animals. An advantage of this compound is that it kills and expels the worm completely thus minimising chances of reinfection. Drug controller has given permission for carrying out clinical trials. A new long-lasting neuroleptic agent has also completed Phase I clinical trial and found safe and non-addicting. This will now be tried in human patients.

Oral contraceptive

The development of a non-steroid oral contraceptive, with minimum hormonal effects, is continuing to show promise at the Central Drug Research Institute, Lucknow. The compound, named as Centchroman, is now under field trials for contraceptive efficacy at three centres of the Indian Council of Medical Research. It is being tried both as a single dose post-coital pill and as a prophylactic given weekly. The results are quite encouraging.

A contraceptive cream for women. in under trial. It is very cheap being made entirely of indigenously available materials. The spermicidal agent is the saponins of soap nut (known in Hindi as *Ritha*). Studies carried out in monkeys indicate that it compares well in efficacy with local contraceptives made of imported materials.

Quick diagnosis of filariasis

A simple and rapid method for immunodiagnosis of filariasis has been developed which permits diagnosis in the early stages of the disease. Antigen prepared from the infective larvae of *Brugia malayi* is injected intradermally into the forearm. The development of a weal is a positive sign of infection. This technique is more convenient than the method of taking the blood from patients at midnight for testing for filarial parasites. The new method is quite specific for filaria and does not give positive results with other helminth infections. The method is now to be tried out on a large population.

BOOK REVIEWS

ELECTRICAL COMMUNICATIONS by R. G. Meadows, *Macmillan Press Ltd.*, Representative in India: 2/10, Ansari Road, New Delhi-110002 1976, Pp. 178, £ 3.25.

THE utilization of electrical signals for the purpose of communication dates back to the early days of Marconi. Since then many books have appeared on electrical communication and communication systems. Unlike many recent ones, the book under review is a heavily condensed text on the subject. However, to consult the book, the background of the subject-matter is necessary.

The book is in the form of summarized notes on the subject. It also contains worked-out examples and problems on electrical communications. The architecture of each chapter is same and is written with three points in view: (a) a brief review of the relevant theory with the summary of important results; (b) section containing worked-out examples; and (c) problems along with their answers. All the three features are well correlated.

The author, who is the Head of the Department of Electronic and Communications Engineering, Polytechnic of North London, England covers many topics in the present well-illustrated text. It includes signal analysis and system response, noise, amplitude and angle modulation systems; pulse and PCM modulation systems; transmission lines and waveguides; antennas; and short wave, microwave and radar systems. The book has been straightforwardly written with little said about the reason, the alternative and the relationship to other approaches. This is so, the reviewer feels, as the author did not aim to present this book as a detailed or basic text on the subject but a ready reference for engineers.

A number of topics of communication included in the book have made the book worthwhile. However, it will not be of use to those who are interested in detailed study. The author, for such a study, should have mentioned the relevant references. It is a refresher type book and is valuable to students studying electronics and electrical engineering for degree or diploma courses. It is also of use to those who have recently entered the engineering profession. All engineers would find something of their interest in it.

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MEDICINAL PLANTS OF INDIA, Vol. I, *Indian Council of Medical Research*, Ansari Nagar, New Delhi, Pp. 488, Rs. 30.00.

AYURVEDA, one of our indigenous schools of medicine based on active principles extracted from plant sources, has been and still is popular in our country; yet there have been relatively few scientific accounts of medicinal plants in India. Moreover, whatever accounts do exist, are scattered in various journals. No doubt, therefore, students of economic botany, pharmacology, clinical medicine, phyto-chemistry and Ayurvedic medicine would welcome this compilation. It gives descriptions of 350 species of medicinal plants. Although listed alphabetically according to their botanical names, their vernacular names have also been given which would facilitate Indian students to correctly identify these plants in the field. A knowledge of vernacular names becomes indispensable when a researcher wishes to gather information about these plants and their medicinal properties from local sources. The description of each plant includes an account, according to the Ayurvedic and the modern systems of medicine, of the physiological processes affected by specific parts of these plants. Depending upon the amount of work done in the field, the chemical nature of the active principles responsible for the therapeutic values of these plants has been described.

Since a fairly elaborate Ayurvedic description has been given about each plant, it is a pity that the basic concepts of Ayurveda have been described in a mere note. Also, this note happens to have been extracted from the Report of the Committee on Indigenous Systems of Medicine (1948), Ministry of Health, Government of India. Surely a fresh description of the pharmacodynamic aspects of Ayurveda written by a specialist would have added to the merit of the book. The authors, however, have made up for this shortcoming by giving a bibliography on Ayurvedic medicine.

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ENGINEERING CHEMISTRY by P.C. Jain, *Dhanpat Rai & Sons* (1976), 1682, Nai Sarak, Delhi-6, pp. 434, Rs. 16.00,

THE standard of a book on a topic like engineering chemistry would largely depend upon its success in highlighting the applications of chemistry in engineering problems. Corrosion, for instance, is a serious problem for engineers. Mechanical, chemical or civil engineers all have to face this problem because the life of a plant/equipment is very much dependent on it. According to an estimate, the direct losses due to corrosion in India amount to about Rs. 200 crores per annum and the money spent in controlling it is of the order of Rs. 50 crores. Obviously, a standard text on this subject is expected to furnish details of the causes and the possible ways of preventing corrosion. It should discuss the important topics like nuclear fuels, water-treatment and high polymers, etc., with an industrial bias.

The author's attempt has been quite successful in this direction. He has brought out a good textbook for engineering students who want to have an over-view of various topics in engineering chemistry. The book, divided into sixteen chapters, is designed for one semester course of engineering students. The author has restricted himself to a selection of more important applications of chemistry in engineering and has a descriptive and concise approach. In the chapter on water treatment, the author has discussed the importance of water as a basic engineering material. The availability of salt-free water is as important for an industry as any other raw material; steam generation is its most important application. The author has discussed in detail the treatment of impure water available from different sources. Frequent use of illustrations has been made to further clarify the subject. But the chapters on nuclear fuels, metallurgical processes, are sketchy. These could be discussed with the inclusion of more industrial details. Few errors of minor character were found in the chapter on high polymers. Rest of the book has been quite clearly and carefully written. The book can serve as a textbook.

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THE PENGUIN DICTIONARY OF PHYSICS edited by Valerie H. Pitt, *Penguin Books*, Representative in India: Penguin Overseas Ltd., 706, Eros Apt 56, Nehru Place, New Delhi, pp. 482, £ 2.00.

THIS highly priced and nicely produced dictionary is an abridged and edited version of *New Dictionary of Physics* prepared by the staff of Laurence Urdang Associates Ltd. and published by Longman in 1975. The terms given in it are of use to students, teachers, technologists, etc. However, the authoress has not specified the level of scientific gentry it caters to. Considering the educational level in India the dictionary would prove of immense value to college-going students, and not below that. Of course, researchers, teachers and all those working in interdisciplinary fields in which physics plays a dominant role, it would be a handy reference.

The novelty of such a higher level science dictionary is in that, to explain a term more elaborately, it is often reinforced with illustrations, graphs, equations, etc., as is the practice adopted in junior level science dictionaries. Every effort has been made to place side by side the terms which are interconnected and need referred to even if one of them is to be checked. The terms are explained in a straightforward and simple language with cross references, marked asterisk, given wherever required. S. I. units are used throughout and the usual tables, e.g., of conversion factors, units, etc., are available at the end for ready reference. An added feature of the dictionary is that synonyms are mentioned. The usual dictionary symbols such as bold letters, italics, dashes, dots, whose presence otherwise irritates one while reading, do not find place in the dictionary. At any rate, a worth possessing dictionary for physics students notwithstanding its high price.

Dilip M. Salwi

MAN AND ENVIRONMENT by Robert Arvill, *Penguin Books*, (same as in the previous one) Pp. 432, £ 1.25.

IF man ever lived in a Garden of Eden, we can be quite certain that there were no conservationists there. There are still many areas of our globe where man has lived for a long time in a reasonable balance with nature. In these areas nobody possibly ever thought of conserving nature, for, conservation was a normal component of existence—good land use and care of the environment were taken for granted.

But most of that is changing, and changing fast. Today even the remotest and most isolated corners of the world are not untouched by that scourge of modern age—pollution. Man's ruthless assault on nature, in quest of more food, more energy, more raw material for his burgeoning industries, has poisoned the air we breathe, water we drink and even the soil we grow our food on. Degradation of the environment is today a worldwide phenomenon. In some countries the problem has become so acute that it is threatening the very survival of man. There is, however, a hopeful sign. Many nations have now recognised environment as a national asset which needs to be conserved. They have introduced measures to prevent pollution of air and water for better land management and conservation of wild life.

Author Robert Arvill is one of the few exponents of conservation planning and development who has detailed practical knowledge in the field. He initiated and organised the European Conservation Year of 1970. Arvill discusses the various issues taking the British Isles as the model, which is perhaps not too perfect a model for such an extensive subject. (How does, for instance, one find here conditions prevailing in the tropics?) He analyses all the aspects —pollution of air and water, land use and management population and, of course, wild life—and correlates them with similar situations prevailing elsewhere. His treatment is detailed, yet the statements are straightforward.

He writes, "An average person requires over 14 kg of air a day and he has to take it as it comes... daily the individual draws 26,000 breaths, many of which—if not all in some cases—are of filthy air." Or take another statement, "Man is two-thirds water. The surface of the globe is seven-tenths water. Yet men and animals still die of thirst, plants wither and deserts increase.... The mass of the people on this earth are profligate in the use of water, probably because so few pay its real worth." His solution is also simple. "Polluter should meet the cost of his pollution," he says. At the same time he also suggests a common framework, especially for industry, by declarations, agreements and standards, and the coordination of methods both at national and international level, to combat pollution and the sharing of knowledge to prevent or eliminate it.

The author is moderate in his stand when he discusses the population problem. He says, "Pessimists liken the world population explosion to cancerous growth—as life gone mad. Optimistic observers predict that, when all the developing countries have had their 'demographic revolution', numbers will return to normal. Population control cannot be formulated properly or translated effectively into a basis for action without full participation by citizens. The personal issues are profound and inadequately understood." But he warns, "any land-use planning that ignores population control simply postpones the day of reckoning."

Looking at it from the conservationist's point of view the problems are gigantic. But they can be surmounted if a proper public opinion is created by educating and informing the people. In this context the book will provide valuable information on the magnitude of the problem how they can be solved through proper environmental planning.

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FLORA OF HASSAN Edited by C. J. Saldanha and D. H. Nicolson, *Amerind Publishing Co.*, N-56 Connaught Place, New Delhi-110001, 1976, Pp. vii+915,

THERE is a great need for an inventory of natural resources of India. Not merely the study of our plant wealth is essential but also evaluation of their components needs immediate attention for utilisation and conservation of germ-plasm in this part of tropical world. Preparation of Floras at state and district level is being encouraged as they form basic units for many purposes. The book under review falls in the second category and is an addition to floristic literature.

Hassan is the headquarters of the district by its name covering one square degree of geographical area and lies in the State of Karnataka. It has scenic topography and enjoyable climate making it a tourist spot. The present book is a guide to its natural history.

The Flora of Hassan has been prepared under the direction of Smithsonian Institution. The contents include a preface, introduction, notes on vegetation, classification, and a flora proper followed index. The text is illustrated with many line diagrams and colour photographs, though the latter are of poor quality.

In the preface the editors state that the book is a contribution to revision of *Flora of Madras Presidency*. The natural vegetation is mostly confined to Manjarabad-Bisle Ghat ranges which is only a fraction of the total area of Peninsular India with much varied ecological conditions. Previous collections from the area are in the National Herbarium should have been first consulted to avoid superfluous distributional records. For convenience an existing system of classification in a major flora is always followed, but in the present work the authors have adapted an arrangement without any advantage. At one level closely allied families like Annonaceae and Myristicaceae are kept together but within family category the genera and species are simply arranged alphabetically. This is not an advancement as the aim of taxonomy is not only identification of plants but also to study evolution at work.

The authors lay emphasis on nomenclature. Though well copied from other sources it lacks authenticity as works on Indian floras are overlooked. For example, new combinations proposed on page 38 for *Desmos ramarowii* (Dunn) Das, p. 248 *Pongamia pinnata* (L) Pierre, p. 315, *Loeseneriella bourdillonii* (Gamble) Raju and p. 320 *Maytenus wightiana* Babu are without taxonomic judgement and proper reference. Similarly notes on distribution of *Kydia calycina* Roxb., *Impatiens kleinii* Wt. & Arn., *Solanum viarum* Dunal and *Cottonia* may mislead the users of this book in thinking these taxa are endemic, though some of these plants are not only widely distributed but also extend to China and American tropics.

Throughout the book the authors have used the names J. Hooker and Lam. for J. D. Hooker and Lamarck respectively. It is confusing. No localities have been given for every plant which is expected to be collected again and this defeats the purpose of a district flora like Hassan. The expenditure involved and research time could have been well spent on a State Flora.

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ELECTRICITY AND ELECTRONICS, by R. C. Bhandari, M. L. Sisodia, N. C. Jain and S. M Khamesara, *Ramesh Book Depot*, Jaipur ; Pp. 220, Rs. 8.75.

CONSIDERING the large number of introductory level text-books on electricity and electronics already available, one may wonder what yet another book on the subject may have to offer in way of improvement upon the others. As mentioned in the preface, this book is primarily written for the final year B. Sc. students of the University of Rajasthan. The objective in writing this book as claimed by the authors, is "to present subject matter in a simple and understandable language".

The contents of the book under review strongly adhere to the prescribed syllabus. As the advantages and shortcomings of various textbook approaches are well known, suffice it is to say that the subject matter of the book lacks coherence, completeness and thereby retains resulting disadvantages.

The book is divided into two parts, viz., electricity and electronics. In the first part, the chapter on ballastic galvanometer begins without an introduction and is devoted to mathematical description thereof. The subsequent chapters on the analysis of transient currents in networks containing R, L, and C ; analysis of A.C. circuits are performed without proper development of the required concepts. The concept of A.C. impedence, introduced in two ways with the same mathematical notation may cause some confusion.

The second part consists of various topics in electronics. The network theorems in this part should have been established in a deductive manner and physical interpretation given. The chapter on conduction of solids and semiconductor diode, electron emission and vacuum diode and rectifiers present the subject in a simple manner. But the transistor circuits still require detailed description. In the analysis of amplifier circuits, the discussion on biasing network should have been included. The concept of feedback, which is considered most important in understanding various electronics circuits, does not find due place. The oscillator circuits should have been discussed in detail.

The appendix on decibel is informative. Another appendix should have been on tube characteristics, instead of the one given on constants of a tube.

At places, the figures require modification and description. Further, the mathematical equations do not provide smooth reading.

All these drawbacks present considerable obstacles in smooth reading and thus make the subject matter abstruse. The problems at the end of every chapter are neither interesting nor challenging.

As this book is written in an orthodox style and has nothing new to offer, its usefulness to the students seems marginal.

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BOOKS RECEIVED

1. **THE WEATHER WEAPON** by N. Seshagiri, *National Book Trust*, A–5, Green Park, N. Delhi-110016, Pp 190, Rs. 10.00
2. **ELEMENTS OF GROUP THEORY FOR PHYSICISTS** by A. W. Joshi, *Wiley Eastern Ltd.*, AB 8 Safdarjung Enclave, N. Delhi-110016. Pp. 324, Rs. 45
3. **INSECTS AND HOST SPECIFICITY** Ed. by T. N. Ananthakrishnan, *Macmillan Co. of India Ltd.*, 2/10, Ansari Road, N. Delhi-110002, Pp. 127, Rs. 16
4. **LINEAR CONTROL THEORY** by B. Chatterjee, *Macmillan Co. of India Ltd.*, 2/10, Ansari Road, N. Delhi-110002, Pp. 332, Rs. 30.00
5. **ELEMENTARY VECTORS** by E. OE. Wolstenholme, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW (England), Pp. 108, $ 7
6. **LUNAR SCIENCE : A post Apollo view**, by Rosstaylor *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 372 $ 19.00
7. **THE RADIO UNIVERSE** by J. S. Hey, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 312, $ 15.50.
8. **EARLY SOLAR PHYSICS** by A. J. Meadows, *Pergamon Press*, Headington Hill Hall, Oxford OX3, England, Pp. 312 $ 13.00.
9. **THE THEORY OF RELATIVITY** by R. K. Patharia, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 316, $ 24.0

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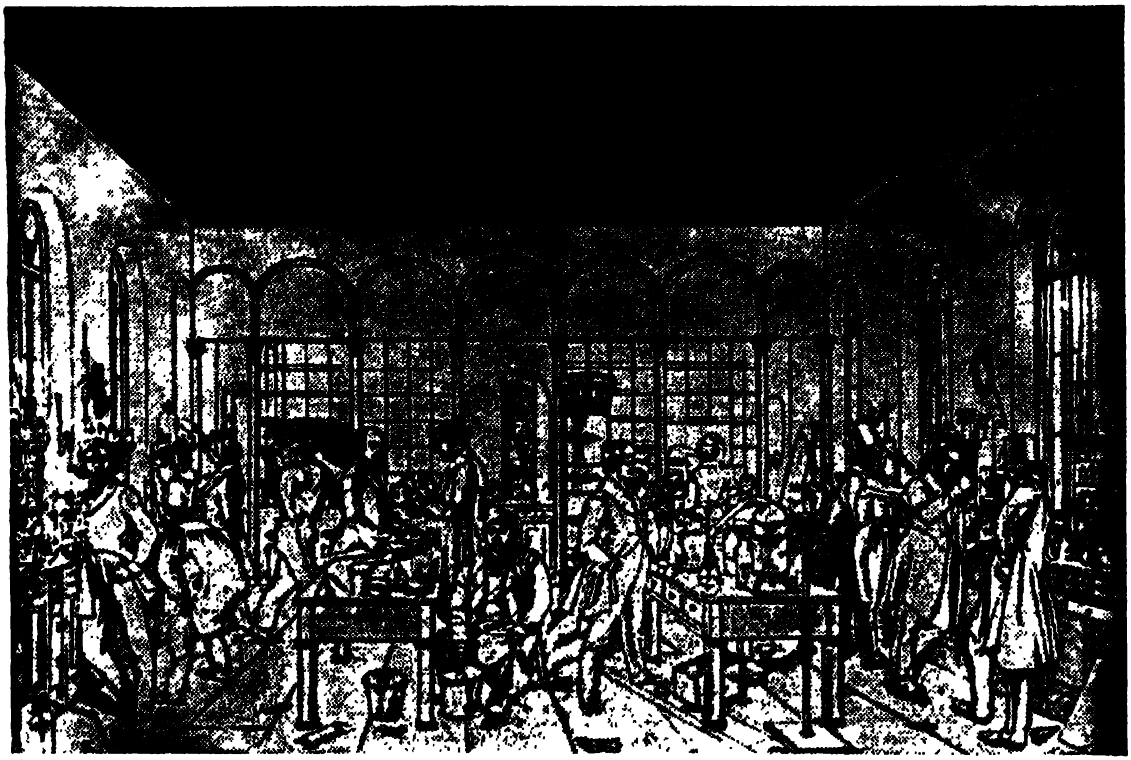

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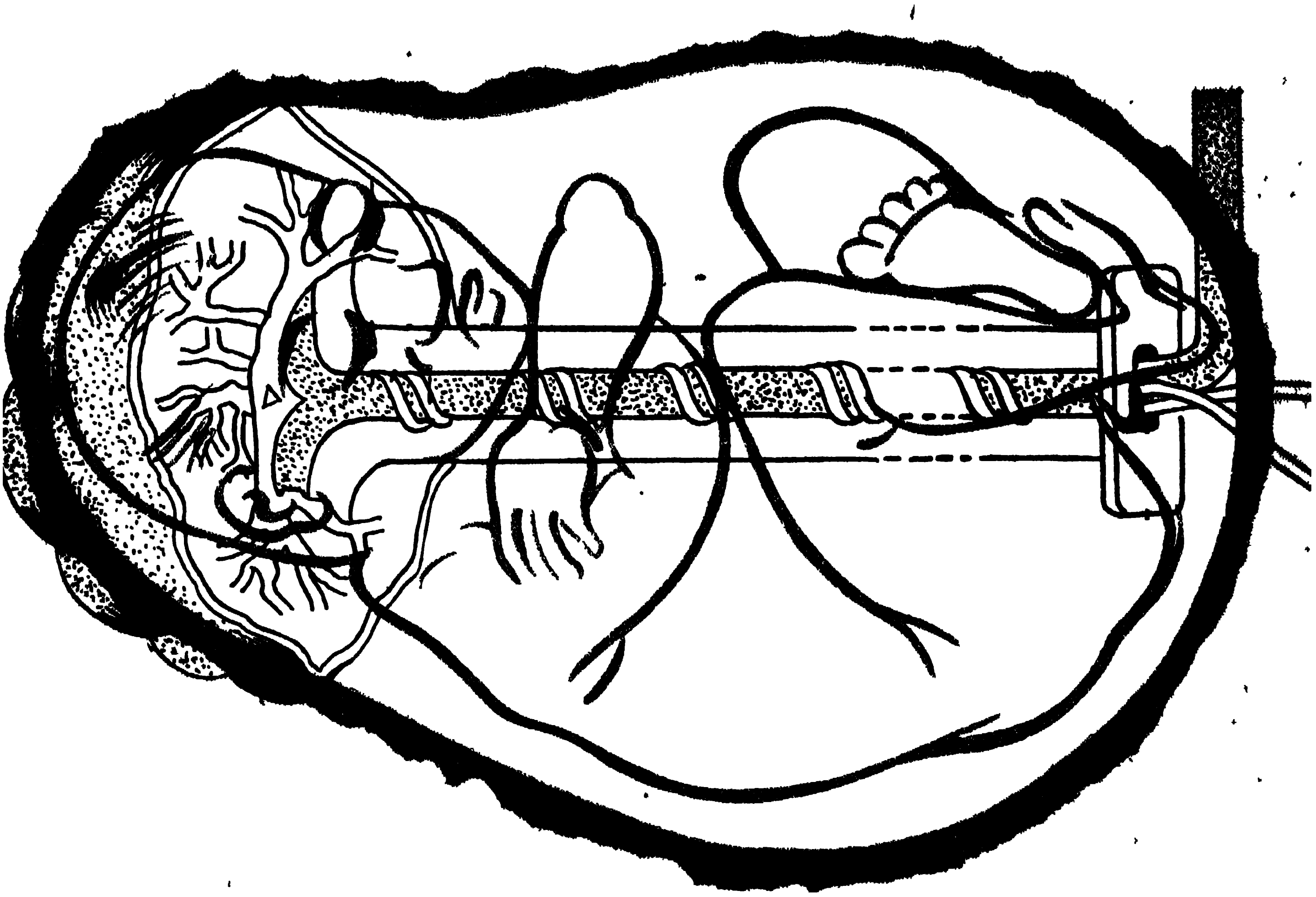

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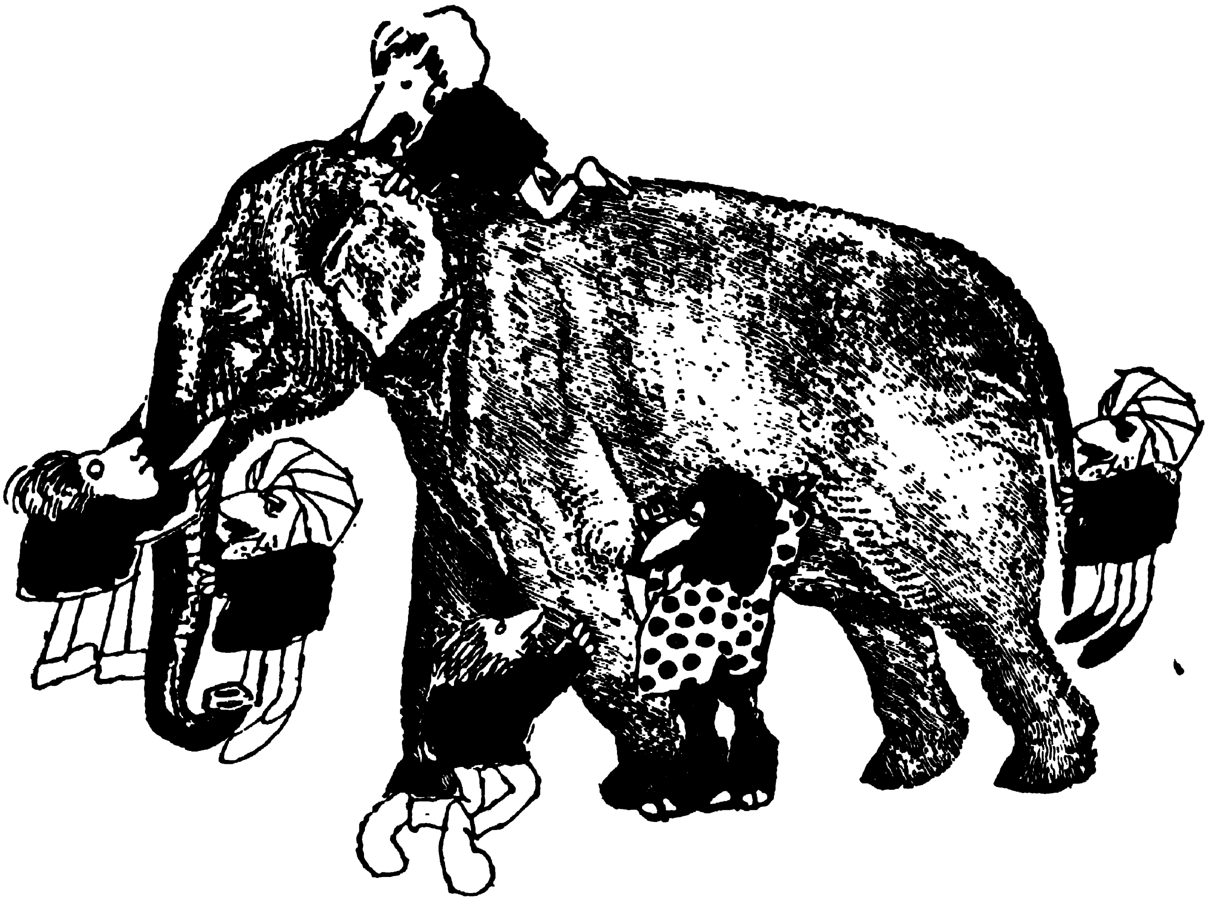

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LETTERS

Science Congress—1977

Sir, I was surprised to see that the Indian Science Congress session at Bhubaneswar in January 1977 was nothing more than a wastage of time, national wealth and science talent.

The report on the Indian Science Congress 1977 (*S.R.*, Feb. 1977) and also the report on the "Science Paper Reading Contest" by D. M. Salwi show that the so called "scientific temper" holds no water in our country. For example, the participants at Bhubaneswar were not scientists but tourists. Barring about half a dozen topics, everything at the science congress was dull and dry.

I feel that magazines like *Science Reporter* are much more useful than science conferences—especially for those who are interested in the advancement of science.

V. K. PANDIT
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Indore-452002 (M.P.)

Microwave sterilization

Sir, Re : **Hazards of microwaves** by Vijender Sharma (*S.R.*, January 1977). It has been mentioned that the microwave radiation causes sterilization. I think it would not be a bad idea if the family planning people do research on it and use it in their campaign. The villagers generally fear surgeon's knife and microwave sterilization will be a good substitute.

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Relativity and tachyons

Sir, The articles published in *S.R.* invariably give students confidence to follow the advanced courses in science and provide teaching staff adequate support for analysis and intelligent interpretation. I like to mention a few more points about **The riddle of gravitation** (*S.R.*, July 1976). Do the tachyons, the particles moving with a velocity greater than the velocity of light, invalidate Einstein's theory of relativity? Einstein's special theory of relativity accounts for only the continuous variation of physical properties of particles, but not the creation of new particles such as pair production. The sub-atomic particles such as mesons are easily created and destroyed. By mutual interactions they exchange their energies and other physical properties, where we cannot expect a continuous variation of any of its physical properties. We can also suppose the generation of particles already travelling faster than light, thereby we can avoid the need for accelerating them through the light barrier. It necessitates us to conclude that the hypothetical 'faster-than-light' particles can never be brought to rest. The velocity of light thus acts as a upper limiting speed for ordinary particles while for tachyons it acts as a lower limit. Now scientists are hunting for tachyons.

M. MEYYAPPAN
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Genetic code

Sir, Although Dr. Ryan's attempt in following the growth of molecular genetics in **The genetic code revisited** (*S.R., Feb. 1977*) was very successful, I would like to make some corrections, additions and comments.

It has been very well established that proteins are synthesized starting with their amino terminus and *m*RNA is translated starting with its 5′p end and the direction or polarity of both transcription (also DNA replication) and translation is the same—5′ to 3′ direction and not 3′ to 5′ as is mentioned in the article. This permits the initiation of translation while the transcription is still continuing, before the completed *m*RNA molecule has left its site of formation. In fact the polymerization proper, whether DNA replication or transcription is always by the accretion of a 5-deoxynucleotide or 5′ nucleotide to the free 3′-OH group of the growing chain, hence the direction would be always 5′ to 3′.

The usual convention of writing nucleotide sequence with 5′-C of ribose (or deoxy) sugar on the left and the 3′-C on the right as mentioned in the article is correct but it is desirable to add p. or OH on its right (e.g., 5′ p., 5′ OH, 3′ OH, etc.) as the case may be.

It will be more correct to say that a cistron of 1000 to 1500 base pairs in a definite sequence of DNA can direct the synthesis of a polypeptide (mol.wt. less than 6000 daltons) and not a protein as mentioned by Dr. Ryan. Because, the average minimum mol.wt. of protein is generally considered to be above 6000 daltons.

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The apparent disagreement over the direction of transcription is easily explained. Firstly, it is always essential to specify the template molecule in question; whether DNA or RNA. Certainly in most cases nucleic acid chains grow in the 5′→3′ direction. However, in transcription when the *m*RNA is growing in the accepted 5′→3′ direction it must follow from the sheer logic of complementarity (that is, by lining up the RNA formed and the corresponding segment of the DNA template) that the DNA sequence is being read in the 3′→5′ direction during transcription.

Secondly (even though I did not review the significance of terminal groups), I agree that it is desirable to indicate them, not only for the sake of completeness but also because it is now known that DNA-polymerase acts as a repair enzyme; working in the 3′→5′ direction if a 3′-OH but not a 3′-p terminus presents, and in the 5′→3′ direction if either a 5′-OH or a 5-p terminus presents.

Lastly, I also agree that proteins in general contain more than the 500 amino acids implied, therefore in context the term polypeptide is preferable. But may I add an informative countercomment. The term dalton should not be used for molecular weights, which are pure ratios and hence dimensionless. However, there is no objection to using it for expressing molar masses, and the like. The dalton represents a mass of 1.663×10^{-27} kg or approximately one hydrogen atom.

JAMES PHILIP RYAN
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Bacterial flagella

Sir, Thanks for the article **Bacterial flagella** by Sukumar Chatterji (*S.R.*, September 1976). As some statements are not uptodate, I would like to add a few new facts relating to the field.

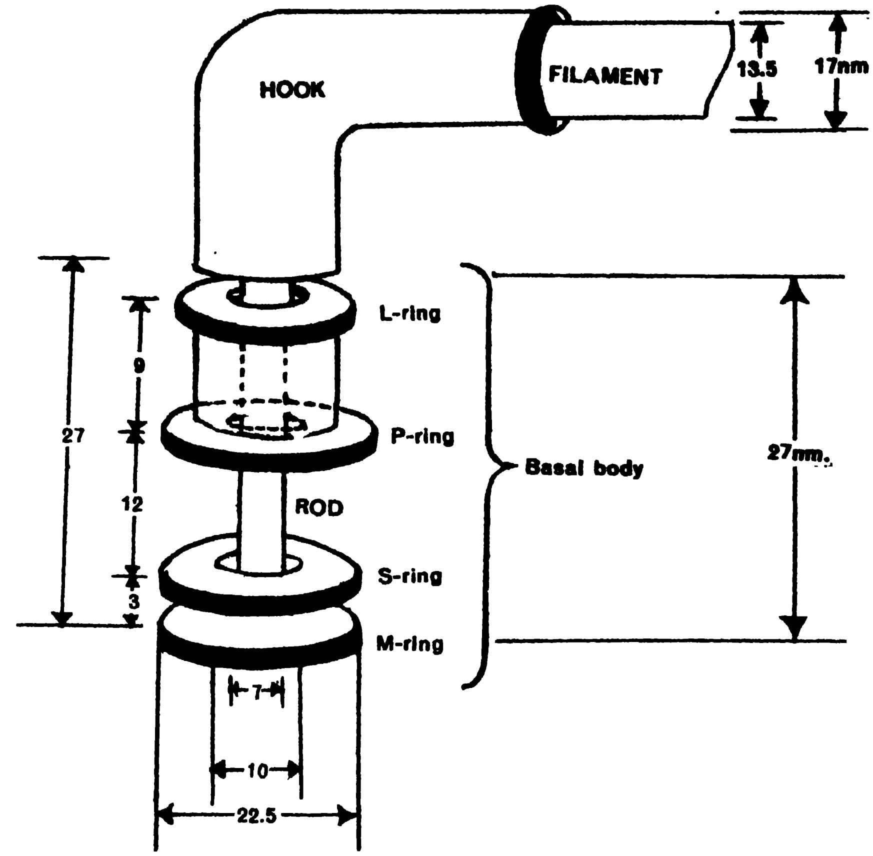

Fig. 1. Structural models demonstrating various parts and location of the basal structure of flagella in gram negative bacteria (*courtesy*: M.L. De-pamhilus & J. Adler)

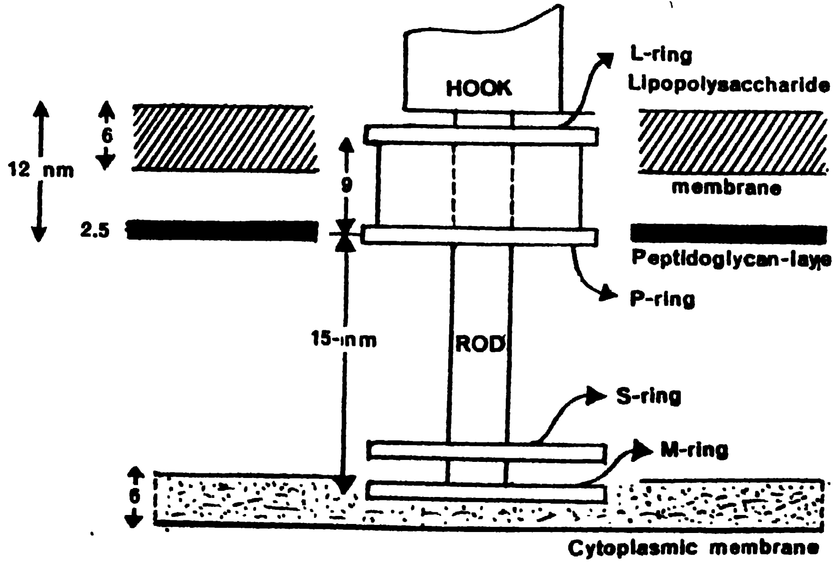

Fig. 2. Different parts and attachment of M-ring to the cytoplasmic membrane in gram-negative

According to Julia-Levy and his coworkers at the University of British Columbia, Vancouver, Canada (1973), diameter of each flagellum ranges from 10-20 nm and the length from 15-20 nm. Sukumar Chatterji writes that flagella contain only two or three tightly wound strands, while modern electron micrographs and three-dimen-

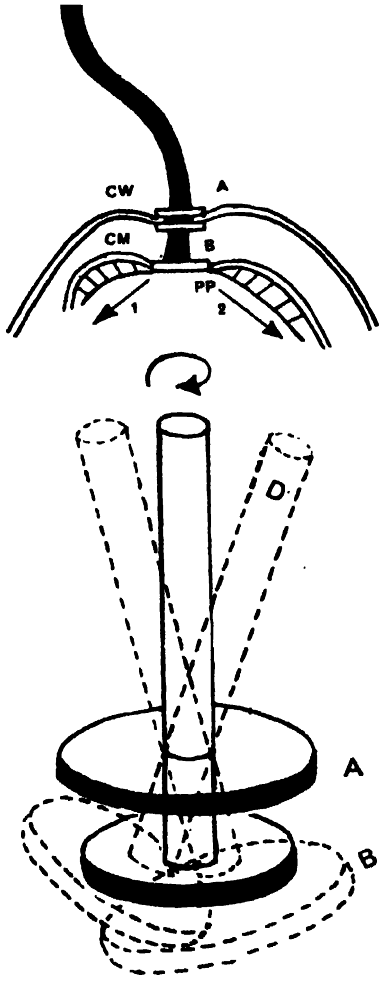

Fig. 3. Schematic model illustrating the possible mechanism of mobility initiated by the basal structure of bacterial flagella (*Courtesy*: Z. Valtuzis & R.N. Doetsch)

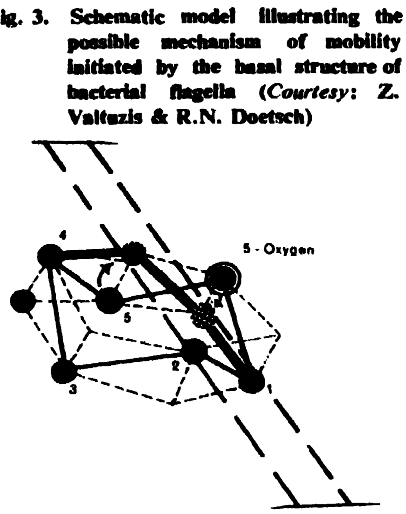

Fig. 4 Action of lysozyme on bacterial cell-wall. Chair conformation is that normally assumed by the rings of aminosugar in the polysaccharide-substrate. When bound against the lysozyme, however, the D-ring is distorted (dark-black thick lines) so that C-atoms 1,2,5 and O-atom-5 lie in a single plane. The distortion eventually assists in breaking the substrate below the E-ring

sional photographs with acoustical-holography have revealed that each flagellum is made up of three distinct parts: the filament, the hook and the basal-body. The filament may consist of as much as six strands (instead of two or three as stated by Sukumar Chatterji), purely of protein flagellin, and in case of *Bacillus pumilus* there are six strands of the globular protein entwined to give a rope-like structure. Flagellin differs in composition from one bacterial species to another but has some constant characteristics, e.g., the absence of cysteine, low levels of aromatic amino acids and high levels of glutamic and aspatric acids.

The second part of flagella is the hook that penetrates the cell wall and joins the filament to the basal-body as indicated in Figs. 1 and 2.

The third part of the flagella is the basal-body which binds the hook and the filament to the cytoplasmic-membrane.

In gram-negative bacteria, basal-body consists of two pairs of rings that are joined by a rod which continues into the hook. Extreme proximal ring of that pair is anchored to the cytoplasmic membrane while the inner ring of the distal pair is probably attached to the murein-layer of cell walls. The outer ring of the distal pair is attached to the lipopolysaccharide layer of the cell wall (Figs. 1 and 2).

In gram-positive bacteria, the basal-body consists of a single pair of rings. The proximal ring is anchored to the cytoplasmic membrane, but there is no special attachment to the cell wall, because of the lack of lipopolysaccharide layer.

It is now well-established that no cytoplasmic granule-like structures, previously thought to be the origin of flagella, exist in the cytoplasm. When the cell wall is dissolved by antibiotics or lysozyme (Fig. 4), the estreme proximal M-ring of the basal body of the flagellum remains attached to the cytoplasmic membrane.

According to Z. Valtuzis and R.N. Doetsch (*J. Bacteriol.*, **100**: 512, 1969), the motion of the flagellum is initiated by a wobbling-action of the basal disc that is embedded in the cytoplasmic membrane (Fig. 3). The hook transmits these undulations to the filament to give a cone of revolution. The gyrating filament drives the cell forward. This theory accounts for the essential nature of the cell reactions in the filament.

(MISS) ANJANA SHARMA
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Leather in many forms

Sir, I read **Leather in many forms** by N. Santappa (*S.R.*, November 1976) with great interest.

1. What is polyurethane finish ?
   (a) What are the materials required?
   (b) Are materials available in the Indian market?
   (c) What is the basic process?
2. Is there any difference between patent finish and glaze finish ? If yes, please give details as asked for in question No. 1 taking into account glaze finish.
3. Often embossing is made to hide grains. Is there any other way to hide them?
4. Please name any book available in the market on various types of finishing with full details of processes.

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1. It is a type of finish, applied after the tanning, fatliqouring and dyeing operations in order to impart an aesthetic look and also to protect the leather surface from the

vagaries of weather. In such finishing operations polyurethanes form one type of finishing agents.

(a) Normally bio-or polyfunctional isocyanates and polyhydroxy esters like organic polyesters are used in the preparation of polyurethanes. But tanners can obtain ready-to-use polyurethane compounds which can be used in solvents or in emulsions.

(b) Ready-to-use polyurethane finishes are available. Polyesters are also available but not isocyanates to our knowledge.

(c) The process involves addition of isocyanates slowly to the moulten polyurethane, diluted with solvents like M.E.K. under reflex at about 60°C temperature.

2. The patent finish and glaze finishes are different. Polyurethane finish is also known as patent finish. In old days patent finish was based on linseed oil lacquer. For glaze finish materials such as protein binders (casein, egg yolk, blood, pigment dyes, formaldehyde, etc.) are made use of. Materials for glaze finish are available indigenously.

The process for preparation of pigments is the same as used in the preparation of pigments applied to textile industry.

3. Patent finish is another way of hiding the grain defects apart from metallic finishes and transfer foil finishes.

4. (1) *Modern Theory & Practice of Leather Manufacture* by K. T. Sarkar, A. M. Sharif, 555, Ponamallee High Road, Madras.

(2) C.L.R.I. publications on various types of leathers, are obtainable from the Director, Central Leather Research Institute, Madras-20.

C. Kotfswara Rao
Scientist
C.L.R.I., Madras-20

Weed menace in India

Sir, Many thanks to V. Bhaskar for his interesting and informative article **Weed menace in India** (*S.R.*, November 1976). Dr. Bhaskar has stated that according to the Forest Research Institute, Dehra Dun, the insect used for biological control of lantana attacked the other economically important species as well. But recently a school teacher who worked on the biological control of lantana showed that the insect used for the biological control of lantana was specific to lantana. This teacher was awarded a cash prize for this work by the I.C.A.R.

I need a clarification on this point.

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Battery eliminator

Sir, I thank you for the article **Battery eliminator** (*S.R.*, March 1977).

The circuit given in Fig. 4 (ii) is however shown with a rectifier bridge with wrongly inter-connected diodes, whereas a similar bridge is correctly shown in Fig. 5.

A minor error as such will lead to serious problems to the home experimenter such as shorting of the secondary winding of the transformer and further causing transformer coil overheating, burning, blowing fuses, etc. The bridge should have been as shown in Fig. 1.

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Medicinal plants

Sir, Apropos of role of medicinal plants in the article **Plants for population control** (*S.R.*, January 1977, p. 39) by Renupada Nandi, perhaps it would be worthwhile to point out that all the starting materials for diosgenin, from which pills for oral contraceptives are prepared, are not easily accessible in the country to meet the required demand. However, *Balanites roxburghii* is found in abundance in arid zones of Delhi, Sikkim, Western Haryana and South India. H. S. Puri (*S.R.*, May 1976, p. 289) stated that the yield of diosgenin from this source is very high. Evidently, it is a better substitute for diosgenin-yielding *Dioscorea* species.

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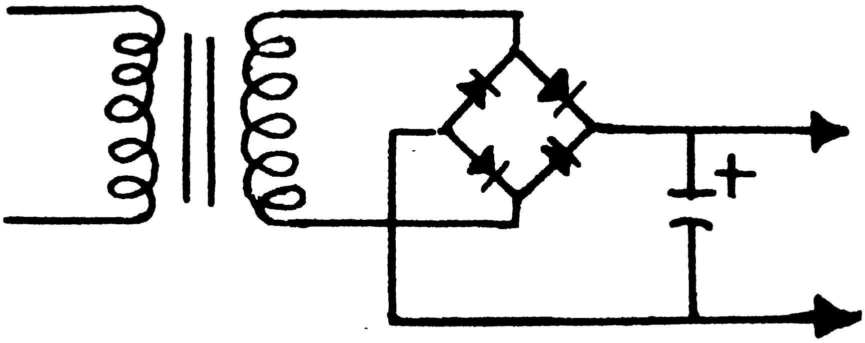
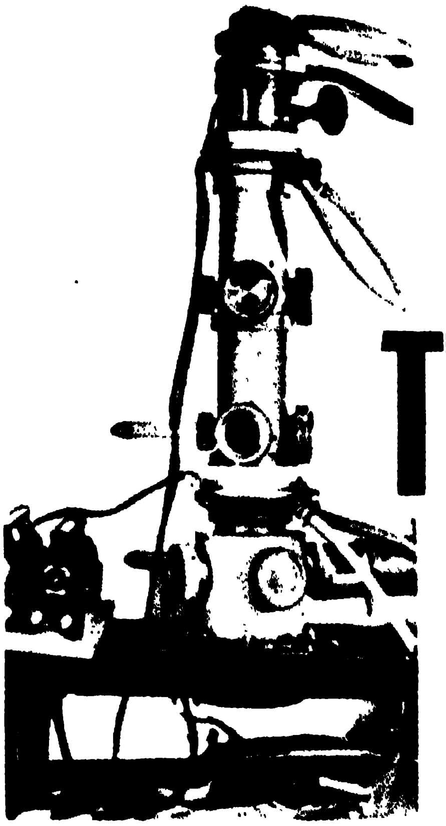


Fig. 1



THE ELECTRON MIC

How did it e

The light microscope reached perfection after more than two centuries of development. The electron microscope reached the comparable level in a short span of two decades

ANIL VISHNU MOHARIR

IN this twentieth century, the term "explorer" can readily be applied to scientists than to those who are engaged in conquering and outlining the unknown areas on this earth. Some seek to uncover the mysteries of the universe around us, while other scientists are expending their energies to reveal the world of matter. The successful exposition of grandeur of the micro-cosmos of matter depends on the development of an instrument capable of extending our vision beyond its natural capacity, so that the information secured can be appreciated by our sense of vision, which is man's most important faculty for the understanding of his environment.

It is a common knowledge that the simplest way to find out more about the fine, detailed structure of an object is to "magnify" it, so that eye can appreciate the greater details in the object and the magnified image has improved upon the resolution of the unaided eye. "Resolution" or "Resolving power", which is the ability to distinguish fine details, is clearly bound up with magnification. Magnification is also a function of the distance of an object from the eye, and as the object is brought closer to the eye, more of the detailed structure can be resolved. Under the best conditions, an unaided normal eye can resolve a distance of about 0.25 mm at 25 cm, which is the least distance of distinct vision. It cannot separate smaller details because of the limits of resolution of the eye lens and the granular structure of the retina which is made up of cells of finite width. It is therefore clear that magnification alone cannot show details. The answer lies in the understanding of the fundamental physical nature of light: it is an electro-magnetic wave

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ROSCOPE
volve?

motion and the waves are of finite length.

Man invented first the simple microscope from the magnifying glasses around 1300 A.D. The compound microscope was the magnificient contribution of 16th century towards this goal of the exploration of matter.

Two centuries later, the introduction of the glass lenses corrected for the intrinsic optical defects like chromatic and spherical aberrations, astigmatism, brought the light microscope to its 'peak' of perfection. And in the concluding process of development of this instrument, Sir George Airy in 1834 conclusively showed, basing his calculations on the wave theory of light, that the limit of close approach for two points in the object, consistent with the possibility of distinguishing their images, is known to be given approximately by

$$\text{Resolving limit} = \frac{0.61\lambda}{N \sin\alpha}$$

where

λ = wavelength of light

N = refracting index of the medium in which the object is situated

α = the semiangle between the axis and the most oblique ray from the axial object.

N Sin α is also called "Numerical aperture."

However, in our pursuit of securing an indefinitely high resolution by using shorter wavelengths, many difficulties are encountered, which are as follows :

1. The surfaces of the optical system must be perfect in both their figure and polish.
2. The optical materials should be perfectly homogeneous.
3. Since air does not transmit radiations beyond 0.18 μ, vacuum- or nitrogen-filled instruments become necessary.
4. The usual refracting media become opaque to the increasingly shorter wavelengths and this requires the use of reflecting instruments.

At this point, the difficulties in (1) above become more severe, as the errors in reflecting surfaces cause about four times the effect of equal errors in refractive surfaces.

The cumulative effect of all such difficulties indicates that we should be content to resolve points closer to 0.1 μ or 10^{-5} cm. The discovery of X-ray diffraction and later the electron diffraction mitigated this trouble. Convenient X-ray wavelengths range from 0.5-2.0 Å i.e., they are four thousand times smaller than that of light waves, but unfortunately lenses for refracting X-rays cannot be realised.

In 1878, Ernst Abbe, in opposition to many contemporary scientists, expressed the view that optical technology had reached a fundamental limit and no further improvement in resolution was possible. He even declared light as a wave motion, whose half wavelength marked an impenetrable limit of resolution for any optical magnifier at about the quarter micron level. Abbe was sure in his mind that a new form of radiations of short wavelength was needed to improve resolution and possibly see the molecular and atomic phenomena. He also declared that a new form of microscope, if it ever emerged, would have little more in common with them than the name. Time has proved that Abbe was quite correct in his resolution limit postulate, but incorrect in his prediction regarding the nature of an ultramicroscope. The later introduction of the polarisation, dark field, phase contrast and fluorescent microscopy during the first half of the twentieth century, did not significantly contribute to the possibility of the direct visualisation of the ultrastructure of living matter.

No means were conceived of resolving finer details until two discoveries were made: (i) The wave properties of moving electrons postulated by a French Physicist Louise de Broglie purely on theoretical reasoning in 1924 and their experimental verification in 1927 by C. J. Davisson and L. H. Germer of Bell Laboratory in America and G. P. Thomson and Reid in Eng-

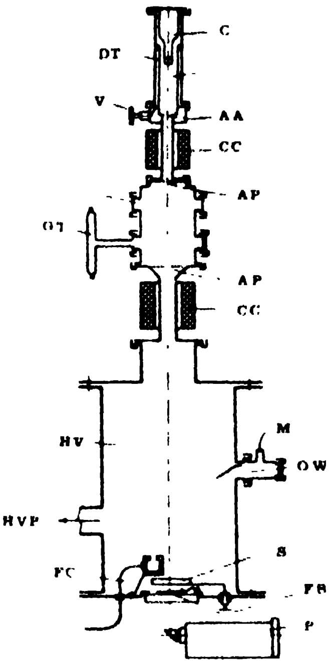

Fig. 1 Line diagram of Electron Optical Test apparatus of Knoll & Ruska used to demonstrate the principle of EM. AA: anode aperture, AP: aperture, C: cathode, CC: concentration coil, DT: gas discharge tube, FC: Faraday cage for measuring beam current, FS: Fluorescent screen, GT: Geissler tube, HV: Region high vacuum, HVP: to the high vacuum pump, M: connection to measuring equipment, OW: observation window, P: Photo-apparatus S observation screen, V: air inlet valve

land, and (ii) the discovery by H. Busch (1926-27) in Germany of the similarity between the effect of a magnetic coil on an electron beam and the effect of a convex lens on a light beam. Since the wavelength of a moving electron is smaller by many orders of magnitude than the shortest wavelength of electromagnetic radiation, these discoveries made it conceivable that extremely small objects might be imaged with an electron beam and electron lenses (The wave length λ for a moving electron according to de Broglie relation is given by $\lambda = h/p$, where h is the Planck's constant and $p = m \times v$, the momentum of the electron of mass m and velocity v. For an electron accelerated to 60 KV, the wavelength is about 0 .05 Å).

The remarkable feature associated with the development of the electron microscope is that while light microscope reached its peak of perfection after more than two centuries of development, the electron microscope reached a comparable level in a short span of two decades. The electron microscope represents thus one of the twentieth century's contributions to this never-ending goal of seeing the atoms and molecules of matter at work.

The history of the development of the electron optics starts more or less with the discovery of the cathode rays and subsequent experiments on cathode rays that conclusively brought to rest the controversy over the corpuscular nature of electrons. E. Weichert (1899) in Germany made the first intentional use of a solenoid for concentration of the cathode rays. In 1903, H. A. Ryan used a short solenoid for the purpose of focussing cathode rays. This work was taken up for further investigations by C. Stöermer who performed a series of extensive experiments and calculations on the trajectories of charged particles in fields, and derived the most basic fundamental equations. In an attempt to apply the results of these investigations and the laws to certain practical scientific and engineering problems, that the subject of "electron optics" was born. However M. Knoll and E. Ruska, in two of their papers published in *Annalen der Physik* in 1932, were the first to use the term "Electron optics."

In 1926-27, H. Busch working in the Physical Institute Jena (Germany), made a theoretical analysis of the action of concentrating coils in which he developed the most fundamental formulae of magnetic electron optics. He subjected these formulae to rigorous experimental checks and found a good agreement between his experiments and theory. The differential equation of the trajectory of an electron developed by Busch is a lens equation, which shows that the angular change in the direction of motion is proportional to the displacement from the axis. If the electrons form a beam with a definite convergence at any Z planes, they will remain a beam at all Z planes. Axially symmetric electric and magnetic fields therefore constitute lenses for the electrons.

H. Busch, however, did not develop formulae for electrostatic lenses, although it is implicit in his equation that the second derivative of the electrostatic potential has a focussing effect similar to that of a magnetic field. Later C. J. Davissan, and C. J. Calbick and E. Bruche and H. Johnnson, in 1931-32, independently demonstrated that symmetrical electrostatic fields could also be used as electron lenses. However, the use of electromagnetic lenses for the projection of extended electron images was first developed by M. Knoll and E. Ruska in 1931, when they extended the iron encapsulation on the focussing coils and thereby shortened the magnetic field and reduced the number of ampere turns required for a given focal length. Knoll and Ruska succeeded in magnifying the electron image formed by the first solenoid by means of a second solenoid placed between the intermediate image and the final screen. The magnification obtained was only seventeen times, nevertheless the basic principles of electron optical magnification had been established.

M. Knoll and E. Ruska were also the first to introduce small apertures for controlling spherical aberrations. The results of these experiments together with electron micrographs of simple objects like the circular and T shaped, multiple apertures, metal meshes, etc., were presented by Knoll on June 4th 1931 at a Crantz Colloquium at the Technische Hoschule, Berlin. (see also box column). These experiments proved that the aberrations of magnetic lenses could be made very much smaller than Busch and practically all other scientists had expected, and that a good resolution was indeed very much within reach. Knoll and Ruska had not even applied for a patent until then. They however followed up their demonstration with a paper *Beitrag Zür geometrischen Elektronenoptik*, that was submitted for publication on the 10th September 1931. This paper is one of the most comprehensive in electron optics theory. Thus the credit for the invention of the electron microscope goes. to M. Knoll and E. Ruska. They were then working at the High Tension Laboratory of the Technical University at Berlin, under Dr. A. Matthias who was then its Head. The development of the electron microscope was actually a byproduct of their work on demountable cathode ray oscillographs, which were being used for the investigation of lightning and other surge phenomena. In 1928, Max Knoll was transferred to the technical University, where a separate electronics laboratory was established for him and he was made its Head. Working in close cooperation with a small group of selected students, he started directing basic research on electron beams and cathode ray oscilloscopes. Knoll divided the main research programme into various related fields ; each forming the doctoral research work of his students. The researchers and their main fields of investigations were: (a) M. M. Freündlich : "Hot cathode electron source and trigger and time base circuits"; (b) H. Knöblach: "The cold cathode electron source"; (c) E. Ruska: "Beam focussing"; (d) H. von Börris:" "Photographic recording methods'; and (e) H. G. Lubszynski: "Electromagnetic shielding:"

M. Knoll left the field of investigation in 1932 but Ruska carried on. By 1933 he had designed a new electron microscope, the real forerunner of the present day machines. This was constructed by incorporating the idea of von Börris of providing "pole pieces" to concentrate the magnetic field into as small an axial region as possible; and the simple idea has dominated the field of electron optics ever since then. The achievement of a resolution of 500 °A was claimed with this new instrument by observing the charred remains of the organic specimens.

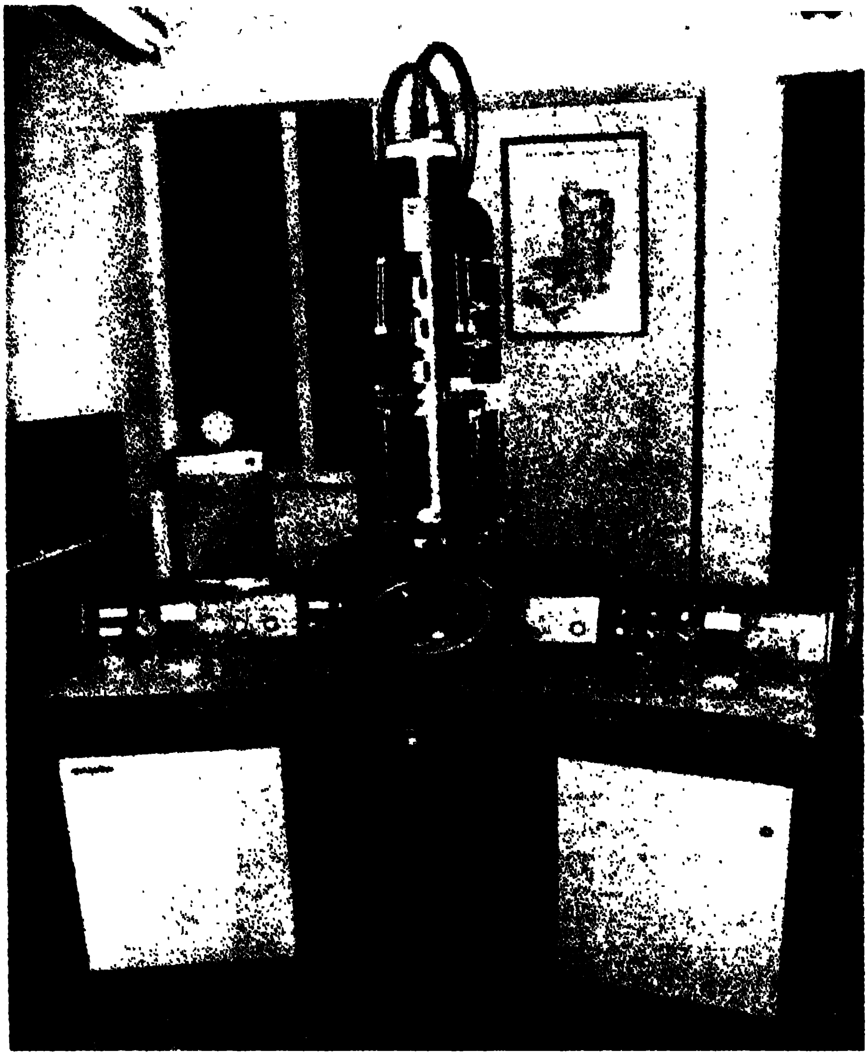

Fig. 2 Modern versatile Phillips EM-300 electrone Microscope with, resolving power better than 5 Å

In Belgium, G. A. Morton, of the University of Brussels, did much of the early work in the biological application of electron microscope. He proposed thinner specimens, higher accelerating potentials and internal photography leading to short-exposure times. These ideas were incorporated later and a new electron microscope improved in many features over its previous instruments was constructed in 1935. The maximum accelerating potential was increased to 100 KV and specimen and camera airlocks were fitted for the first time in the instrument. These airlocks have made a decisive contribution in the design and practical operation of electron microscopes. Today, with the growth and advancements of several new techniques used for the preparation of specimens for electron microscopy, the electron microscope has become an indespensable tool for any biological research

The work of Knoll and Ruska had triggered off experiments in electron optics in almost all the industrially advanced countries of the world. The first commercial electron microscope EM1 was built

EM patent controversy

REINHOLD Rüdenberg, of the Siemens Schuckertwerke, Berlin is described as the inventor of the electron microscope in the Patent law, since Rudenberg was the first man to apply for a comprehensive patent with a priority of 31st May 1931, i.e., only five days before Max Knoll and E. Ruska demonstrated the working of their first ever electron microscope to the scientists at the Crantz Colloquium held on the 4th June 1931. Rüdenberg's patent applications were granted in Austria, France, Switzerland and U.S.A. but were refused in Germany. These patents are broad in their specifications, although no technical details are given. The German patent was, however, granted twenty years later with the original priority and Max Knoll and E. Ruska are the users of this patent. It is known that R. Rüdenberg although attended Knoll's lecture on the 4th June 1931 at the Crantz Colloquium, did not himself take part in the discussion that followed after the lecture. The curious history of his patents has never been known. In a letter to the Editor of the *Journal of Applied Physics* 1943, **14**, 434, Rüdenberg has pleaded for his association with the development of the electron microscope. Quoting excerpts from his patent applications, he even claims himself to be the man who first conceived the possibility of constructing such a microscope. But since no record is available where Rüdenberg or his associates had published their experimental results on electron optics, it is safe to say that though he, holds the first patent application, did not however contribute either directly or indirectly to the development of the electron microscope.

A.V.M.

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by the Metropolitan Vickers Electrical Company for Professor L. C. Martin at the Imperial College London in 1935. However, the series production of electron microscopes had begun in 1938 by the firm "Siemens Halske", Germany, under E. Ruska and B. von Börris. In 1941, R.C.A. model B in America was accomplished by V. K. Zworykin, J. Hillier and E. G. Ramberg, with many advanced features such as electronically stabilized accelerating voltages and lens current supplies. In 1940, M. von Ardenne in Germany is reported to have had produced a universal electron microscope of advanced design with a resolution of 30 Å. Facilities for producing dark field and stereo images were incorporated and for the first time a second condenser lens was introduced by means of which a fine electron probe of less than one micron in diameter could be focussed on to the specimen. M. von Ardenne also wrote an excellent comprehensive book in 1940 that helped the rapid expansion of electron microscopy. In 1945, electron microscope with three stage imaging system was built by G. A. Morton and associates at the Stanford University, which greatly increased the range of magnification. At about the same time J. B. Lé Poole of the Institute for Electron Microscopy Delft, Netherlands, had independently arrived at the principle of the intermediate projector lens as a means of extending the range of magnification.

The most recent growth of electron optics has been stimulated by the demands of nuclear physics. The electron spectrometers of high resolving and collecting power, the techniques of particle acceleration, etc., have all favoured the development of electron optics in the relativistic region of highest electron velocities.

Commercial models of electron microscopes of varying features are now available from several manufacturers and the highest resolution that can be achieved with a modern versatile machine is 2.5 Å in the crystalline specimens and about 10 Å in biological specimens. Also, the modern electron microscopes are being increasingly made automatic in operation except the actual screening. Moreover, the single equipment with the help of requisite accessories can perform stereo, dark field and normal transmission electron microscopy, electron diffraction, and X-ray elemental analysis of the specimen of interest, and also the scanning electron microscopy. In short, these are most versatile in their design and operation and unless a thoroughly trained man is at the helm of affairs of an electron microscope laboratory the smooth functioning and maintenance of the microscope is a very costly affair. Although the microscope, unlike other scientific equipments, has been designed to increase the angle of vision, its purpose is to take the faculty of sight into a completely new world which only a skilled electron microscopist can interpret.

In the gap between the upper limits of molecular level and lower limit of resolution of the light microscope lies the answers to most of our fundamental problems of technological, biological and medical significance. Let us see how man succeeds to solve them.

(*Continued on page 294*)

GAMMA RAY
SPECTROMETER

It is the extremely high resolution capacity of the Ge(Li) detector which makes it preferable to a scintillation detector

K. VENKATA RAMANIAH
K. VENKATA REDDY

THE use of lithium-drifted germanium detectors has revolutionised the gamma ray spectroscopy in the last few years. It is the extremely high resolution capacity of the Ge(Li) detector that distinguishes it from and often makes it the detector of choice over the scintillation detector. The optimised Ge(Li) detector usually produces resolutions between a factor of ten and twenty better than NaI (Tl) scintillation detectors over most of the energy range of interest.

The two old methods of energy measurements of nuclear radiations, viz., the organic or inorganic scintillation spectrometers or gaseous ionisation chambers and the bent-crystal spectrometers, represent two extremes in quality of performance and cost. Systems involving the former methods are less expensive but poor in resolution. The solid-state detector Ge(Li) possesses to a great extent the high quality performance of crystal diffraction spectrometer and to some extent the conventional type.

There are primarily four types of Ge(Li) detectors in use today; (i) the thin window x-ray detector, (ii) the planar detector, (iii) the cylindrical symmetric or coaxial detector, and (iv) the single open ended circular or tropozoidal detector. The largest commercial single germanium detector currently available is of about 400 cm^3 volume as against the 350 cm^3 for the 3"×3" long NaI(Tl) detector. The very narrowness of the peak upon a relatively featureless background helps us in distinguishing it. In this sense, greater resolution can substitute for greater absolute efficiency in the detection of the presence of a particular gamma ray. It is, for instance, not at all common for several gamma rays to be found where one was suspected from scintillation measurements. High resolution also implies, if adequate calibration is possible, more precise energy measurements of gamma transitions. The combined effects often make it possible to assign levels and branching ratios in complex gamma decay schemes on the basis of single spectrum (not involving coincidence studies).alone to a much greater degree of certainty that is normally possible with scintillation detectors.

The Ge(Li) detector influenced the expansion of multichannel analyser to a large number of channels. The energy and the intensity data, which can be obtained with careful experimental techniques, are refining the precision to which nuclear energy levels are known and as a consequence will eventually help to bring

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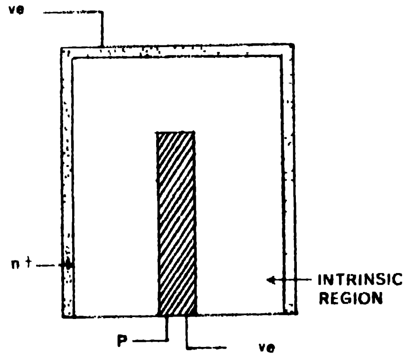

Fig. 1. A vertical section through a Ge(Li) detector. The hatched areas represent the P-type of material and clear portions represent the compensated region of lithium drift T

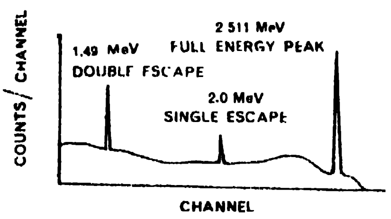

Fig. 2. Typical spectrum for incident gamma energy of 2.511 MeV

about the next phase in the refinement of nuclear theory.

Not only are these detectors playing a major role in the nuclear energy level and decay scheme area, but are also assuming an important role in almost every branch of natural sciences. Their use in activation analysis is readily acknowledged. An area where they are of major importance is the biomedical and environmental studies. They are also being used in certain branches of criminology and geophysics. Their ability to resolve many constituents in a complex mixture of radio nuclides, where concentrations differ considerably, has led to the elimination of many tedious and time consuming chemical separations. This is of particular importance in the analysis of both very short and long half-life fission products. Such products occur in nuclear reactor fuel elements, and an analysis of the locations of the various fission products leads to their better understanding. Eventually a more efficient element can be developed for reactors. These are a few of the many disciplines and areas in which Ge(Li) detectors are important.

The basic principle of operation of a solid-state detector is the same well-known principle of the ionisation chamber, the medium of detection is gas or air. It is possible to use single germanium crystals as detectors due to the process of lithium drift. The drifting of lithium produces an intrinsic region in which the acceptors and the donor atoms are effectively compensated. This situation will remain so as long as the devices are maintained at reduced temperatures. A Ge(Li) detector consists of an (n-i-p) junction device prepared by careful process decribed below.

The first step is usually the preparation of a cylindrical piece of high quality germanium by zone refining techniques. The next step is to diffuse lithium ions into germanium so that n-type region is formed. The lithium ions are then allowed to drift towards the central core under the influence of intense electric field. The whole process is controlled carefully. The drifted ions of lithium are effective in compensating for, or neutralising the p-type impurities in the germanium and then give rise to a region of intrinsic or high resistivity material. A typical cross-section of a Ge(Li) detector is shown in Fig. 1. The intrinsic region forms the active volume of the detector where the ionising radiations (gamma rays) create hole-electron pairs which are collected by external electric field.

Back biasing the P and N junctions of the diode permits the collection without multiplication of all charge carriers, that is, electrons and holes are formed in pairs in the intrinsic region. The detection of gamma rays proceeds as with all detectors with one of the three types of primary interaction, namely, photoelectric effect, Compton effect, or pair production, resulting in the gamma ray giving all or part of its energy to the kinetic energy of an electron or electron-positron pair. In the photoelectric process the gamma ray or X-ray gives all of its energy to the recoil electron. It is the recoil electron that produces the electron-hole pairs in the detector

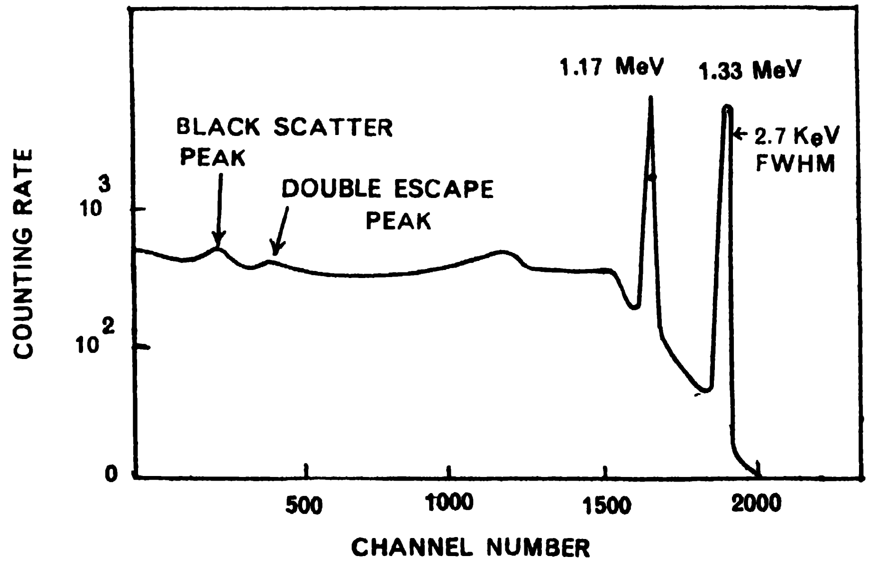

Fig. 3. Typical gamma ray spectrum of ^{60}Co with a Ge (Li) spectrometer

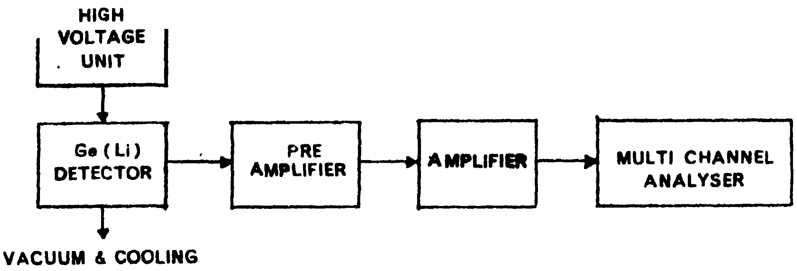

Fig. 4. Block diagram of the electronic system

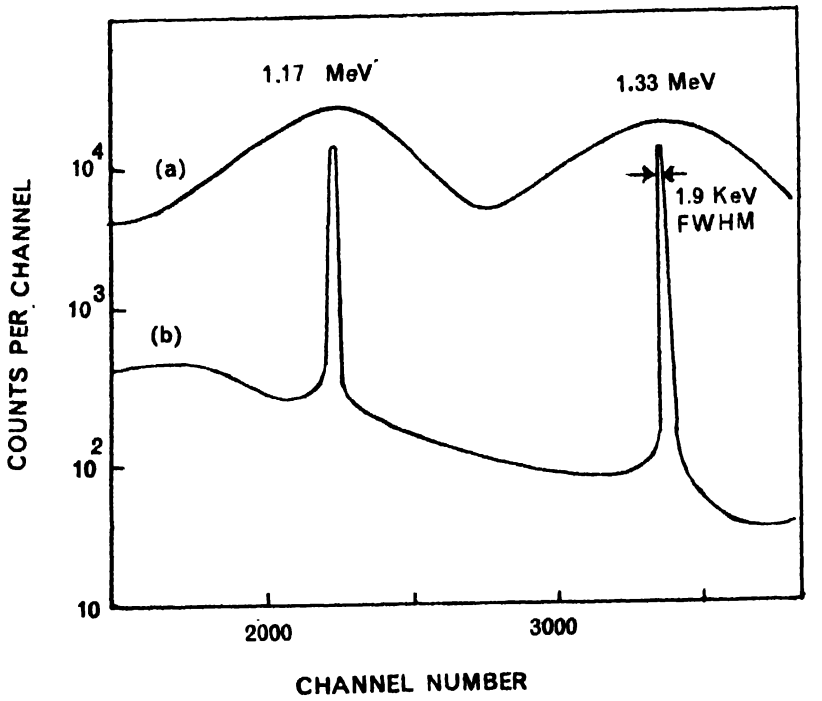

Fig. 5. Gamma ray spectrum of ^{60}Co: (a) with NaI (Tl) scintillator, and with (b) ORTEC Ge (Li) detector

to yield the output pulse. For the photoelectric process, the output pulse from the detector is proportional to the energy of the gamma or X-ray that produced the interaction. In the spectrum these events will show up as photo peaks. In the Compton process there is a distribution of the pulse amplitudes upto some maximum pulse height. This maximum pulse height produces the Compton edge and there is a statistical probability that each event can produce a pulse with any height upto this maximum with about an equal chance. Thus Compton events will provide a well distributed low-energy area in the spectrum as shown in Fig. 2. The pair production process can also provide a total absorption of the gamma ray energy. The gamma ray enters the detector and creates an electron-positron pair. From the law of conservation of mass and energy it follows that the initial gamma ray must have an energy of atleast 1.02 MeV, because it takes that much energy to create both the negative and positive electrons. The net mass that is produced is two electron masses, and this satisfies the law of conservation of energy, $E=mc^2$. The negative electron will produce a pulse whose magnitude is proportional to the energy of the $e^-(E_e^-)$. The postiron will produce a pulse proportional to (E_e+). Since these two pulses are produced simultaneously, the output pulse will be the sum of the two pulses. When the positron is annihilated in the detector, the annihilation radiation γ_1 and γ_2 will be produced. It is possible for only one, γ_1 or γ_2, to make a photoelectric interaction in the detector. In such cases the total energy absorbed is 0.511 MeV less than the original incident gamma energy. It is also possible for both gamma energy to produce photoelectric interactions without escaping, with all the original energy then being left in the detector. Therefore in the spectrum that is measured, there will be three peaks for each gamma energy. These peaks are labelled full-energy peak, single-escape peak, and double-escape peak, and they will be separated by 0.511 MeV increments. Fig. 2(a) shows a typical spectrum that would be obtained for an incident gamma ray energy of 2.511 MeV by using a biased amplifier to eliminate the lower energies and to expand the distribution of the higher-energy pulses across the range that is measured. The single escape peak occurs at (E–0.511 MeV) or 2.00 MeV and the double-escape peak occurs at (E–1.02 MeV) or 1.49 MeV. The full energy peak represents those events for which there was a combination pair production and photoelectric effect in which all the energy was absorbed in the detector.

The extremely high resolution capabilities of the Ge(Li) detector arise from the small energy gap for this material which results in only about 2.9 eV, being required on the average for the production

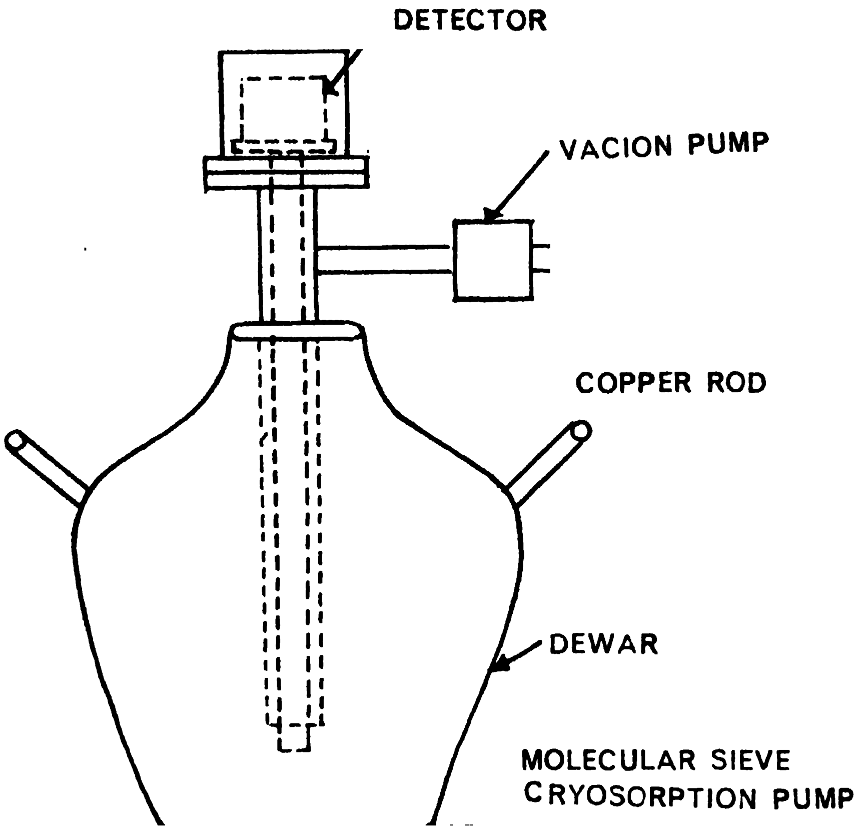

Fig. 6. Detector cryostat arrangement

of each electron-hole pair. The fact that energy is partitioned between the electron-hole creation and the phonon excitation process in a statistical but practically correlated manner, leads to fluctuation in the number of electron-hole pairs created for a given energy. This variance leads to a fundamental limitation of the minimum resolution that may be observed with an otherwise perfect detector. This leads to the best theoretical resolution of an ideal detector expressed as the full-width at half maximum (FWHM) of 0.50 keV at 100 keV, 1.50 keV at 1 MeV and 5.0 keV at 10 MeV.

A typical gamma ray spectrum of ^{60}Co observed with a Ge(Li) detector is shown in Fig. 3 with the Ge(Li), and the associated electronic set-up in Fig. 4. It consists of a full-energy peak corresponding to photoelectric absorption and a continuous Compton distribution. If the gamma ray energies are well above 1.02 MeV, one gets peaks corresponding to the escape of one or both annihilation radiation (0.5 MeV) produced after pair production.

The superior energy resolution obtainable with a Ge(Li) detector is illustrated in Fig. 5 which shows a comparison of ^{60}Co spectra of gamma rays taken with a 3″×3″ NaI(Tl) scintillation detector and an ORTEC Ge(Li) detector.

The resolution of the Ge(Li) detector is limited by the electronic noise contributed by the pre-amplifier and the amplifier of the spectrometer. The pre-amplifiers are carefully designed employing field effect transistors (FET). The contribution of noise by the pre-amplifier is described in terms of W_0, the FWHM in keV at zero capacitance (no detector). The function of the pre-amplifier is to transform the low-level current pulse from the detector to a voltage pulse, amplifying it suitably and provide a driver capable of transmitting the signal over sometimes longer lengths of coaxial cable to the input of the amplifier. Commercially this is accomplished with a charge sensitive pre-amplifier utilising an FET input stage. Although it has been well established that improvement up to 30—40 per cent in the pre-amplifier noise-figure can be obtained by cooling the FET to an optimum temperature.

The main amplifier is of equally sophisticated design and it has to have good gain-stability and good pulse-shaping quality. Further, the amplifier resolution should not deteriorate with higher counting rates. This is achieved by employing pole-zero cancellation and base-line restoration techniques in the amplifier circuit. To take advantage of the excellent energy resolution of the Ge(Li) detector, one uses a 4096 channel analyser and the main amplifier is followed by a biased amplifier which permits an expansion of any part of the gamma ray spectrum. In view of the excellent resolution of the Ge(Li) detector, the energy determination of the different gamma components is to be made very carefully. The peak position is carefully determined by knowing the peak profile. This analysis is performed by a computer program.

The linearity of the system is measured with an electronic pulser. Various gamma ray standards are used to check the response of the detector and to calibrate the spectrometer. Energy standards available over a wide range of gamma ray energies are used for this purpose. Once the energy of some gamma rays of a given spectrum are reliably

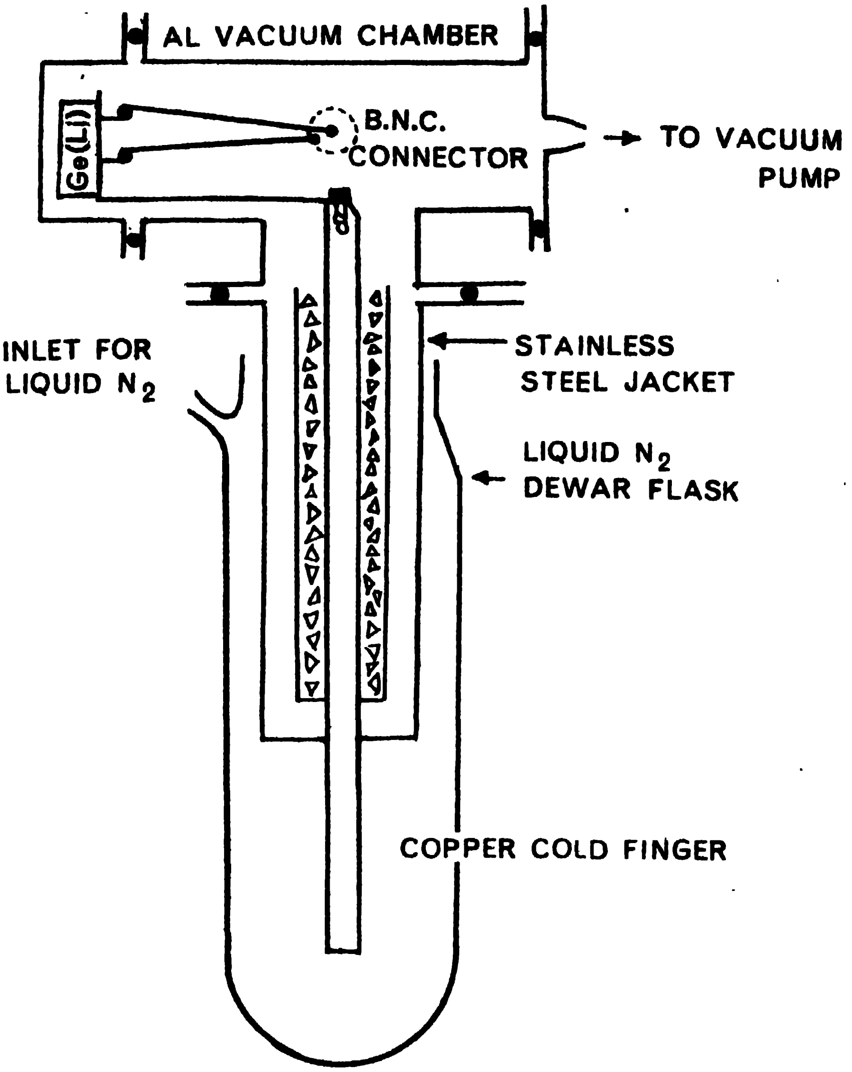

Fig. 7. Details of the Cryostat-Dewar assembly for use with a Ge (Li) detector

determined, one can use these for internal calibration. The efficiency of the Ge(Li) detector must be determined before any quantitative analysis of the relative intensities of gamma rays is possible.

The use of high resolution Ge(Li) in a more complex arrangement usually involves coincidence arrangements with the other detectors. It requires the consideration of the characteristics of the detector in the time domain. Coincidence arrangements generally involve a further reduction of efficiency which may normally be expected to require the acceptance of high counting rates which almost inevitably produce degradation of the system's resolution.

The Ge(Li) detector has to be operated at 77°K (liquid nitrogen temperature) in order to keep the leakage current at a lowest possible value. The detector is usually kept in vacuum maintained by a zeolite sorption pump or an ion pump. The detector characteristics worsen if it is exposed to room temperature for a long time. A typical Ge(Li) detector-Cryostat system is shown in Fig. 6. The detector is housed in a small aluminium chamber with vacuum inside. The vacuum is maintained by a cryo-sorption pump and a vacuum ion pump as shown in Fig. 7. The cryo-sorption pump material (molecular sieve/activated charcoal) is located between two concentric stainless steel tubes surrounding the copper cold-finger. The cryo-sorption pump creates adequate vacuum in the chamber for start up, after which the one litre per second vacuum ion pump takes over and maintains a high vacuum of the order of 10^{-6}. A control unit supplies the high voltage to the vacuum ion pump and also measures the current in the pump. The ion current is related to the vacuum in the detector chamber. The liquid nitrogen consumption of the system is approximately 10 litres per week. Constant attention should be paid to the shipment of the liquid nitrozen regularly so that the detector is protected from the accidental heating up to the room temperature.

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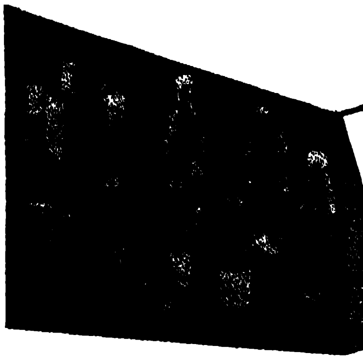

ORGANOTIN CHEMICALS IN Industry

Tin is a versatile metal of many uses in a whole range of industries. Uses of its compounds, the organotins, extend into a vast number of fields

S. N. BHATTACHARYA

TIN, the element of atomic number 50, is a member of Group IV of the periodic table which also contains carbon, silicon, germanium and lead. It is a versatile metal of many uses in a whole range of industries. Its chemical compounds are no less important individually. Their uses extend into a vast number of totally different fields.

Tin is capable of forming organometallic compounds called "organotins". They contain 1 to 4 carbon atoms bonded directly to it. Organotins were for a long time only laboratory curiosities. Organic compounds of tin containing bivalent metal atom (Sn^{2+}) are not well-known. These species are highly reactive and unstable. Nowadays, the industrial application of organotin chemicals is so widespread and specialised that it is difficult to grasp the full potential of these compounds. It is considered worthwhile to summarise in this article the salient features of the commercially important organotin chemicals and to outline their scope in the major areas of use.

Four series of organotin chemicals are known, categorised as R_4Sn, R_3SnX_2, R_2SnX_3 and $RSnX_3$. Quantitywise, however, the types R_3SnX and R_2SnX_2, strongly dominate the field of applications. In compounds of commercial importance R is usually a butyl, octyl, phenyl or cyclohexyl and X is commonly chloride, fluoride, oxide, hydroxide, carboxylates or thioiate.

The histogram (Fig. 1) shows the rapid increase in the last decade in the consumption of organotins which is an indication of the advances made in the technology of their use. Their total commercial production is currently touching the limit of 25,000 tons at an estimated value of 450 million rupees. These figures are however expected to rise rapidly over the next few years.

Manufacturing processes

For the manufacture of commercially important organotins four different methods are presently used. In three of these the preparation of compounds R_4Sn from $SnCl_4$ (reactions i-iii) constitute the first step:

The Grignard process

$SnCl_4 + 4RMgCl \rightarrow R_4Sn + 4MgCl_2$
(R=phenyl, butyl and octyl) ...(i)

The Wurtz method

$SnCl_4 + 4RCl + 8Na \rightarrow R_4Sn + 8NaCl$ (R=butyl) ...(ii)

The aluminium-alkyl technique

$3SnCl_4 + 4R_3Al \rightarrow 3R_4Sn + 4AlCl_3$
(R=O ctye) ...(iii)

Relative ease and efficiency, with which an organic group can be redistributed among the tin atoms (reactions iv-vi), are the most unusual features of organotin chemistry and constitute an essential economic factor for the production of organotin chemicals in very high yields starting from tetraorganotins.

$3R_4Sn + SnCl_4 \rightarrow 4R_3SnCl$ ..(iv)
$R_4Sn + SnCl_4 \rightarrow 2R_2SnCl_2$ ..(v)
$R_4Sn + 3SnCl_4 \rightarrow 4RSnCl_3$ ..(vi)

The subsequent conversion of these chlorides into several industrially

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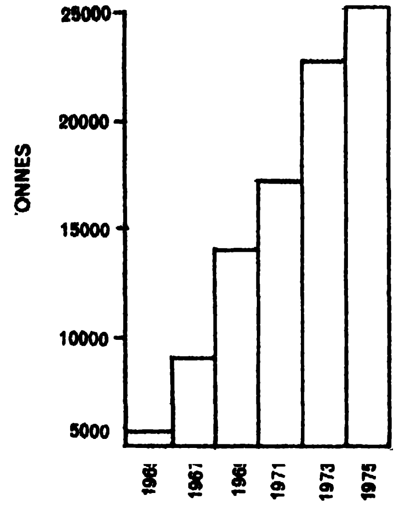

Fig. 1. Growth in the world consumption of organotins

important derivatives offers no difficulties and involves simple exchange reactions.

The fourth technical method is the so-called direct synthesis and involves reaction between tin metal and alkyl halide at elevated temperatures (> 150°C) in presence of certain catalysts.

$$Sn + 2RX \rightarrow R_2SnX_2 \qquad \text{(vii)}$$

Tetraorganotins (R_4Sn)

Although some of these compounds are used commercially as intermediates in the preparation of other organotin compounds, their industrial usage is presently not high. Tetrabutyltin has found commercial use as a corrosion inhibiting additive to lubricating oils of mineral hydrocarbon origin, which are normally corrosive towards bearing metal alloys. Since aryl groups attached to tin are readily removed by mineral acids such as HCl, this property makes them useful as scavengers of traces of such acids. Both tetrabutyl and tetraphenyltin are used in combination with $AlCl_3$ and certain transition metal chlorides as catalysts for low pressure polymerisation of olefins.

Triorganotin compounds (R_3SnX)

Triorganotin compounds form one of the most important classes of organotins in view of their wide commercial use as insecticides and weedicides. Whilst the nature of the group R strongly influences the biological properties of the compound, the group X seems to have no direct influence on the biological properties except through its effect on solubility and volatility. A striking feature of these compounds is that, unlike, for example lead, mercury or arsenic, their biological activity is manifest only in certain organotins; inorganic tin is completely non-toxic. The two most important classes of compounds are the tributyl and triphenyl tin derivatives, both combine high biological activity with low mammalian toxicity.

Timber preservation

Triorganotin compounds are extremely useful in the preservation of wood. The best known compounds for this purpose are the tributyl tin derivatives as they are highly active against both fungi and the insects which attack wood. Tributyltin oxide, also known as TBTO, is a clear, colourless liquid with little odour at the concentrations employed. It has low mammalian toxicity, is resistant to leaching and does not increase inflammability.

Some researches have been carried out to establish the mechanism of protective action of triorganotins and to determine the factors which influence their penetration into the wood. They are applied by dipping, spraying or by vacuum impregnation method using a suitable organic solvent system. The growing commercial importance of this use is reflected in the fact that in the U.K. alone there are over thirty formulations containing organotins commercially available for timber preservations. The National House-Builder Registration Council of England requires that all wooden window joinery be given a preservative treatment for which a one-minute dip in organic solvent containing 0.5 % TBTO is considered suitable. Some aqueous formulations are being developed which would reduce application costs and prevent fire hazards in wooden materials in confined spaces, e.g., timbers in mines, attics or basements.

Another related and interesting preservative developed in 1973 is based on a mixture of TBTO, and a quaternary ammonium compound. This solution has been used in eradicating and inhibiting the growth of algae, mosses, lichens and bacterial slime on buildings, monuments and pavements. Such treatments, though toxic to the foulant, nevertheless cause no damage to the stone either by corrosion or staining.

Marine antifouling paints

The hulls of boats which are in prolonged contact with water are susceptible to attachment by plant growth and adherence of marine organisms such as barnacles, molluscs (especially mussels and oysters), tube worms, hydroids and sponges. The latter can seriously interfere with the running efficiency of the vessel by causing hull friction increasing fuel consumption and decreasing maximum speed. Tributyltin derivatives, e.g.,oxide and fluoride, are finding increasing use in antifouling paints which protect hulls against fouling (Fig. 2). These compounds being colourless allow light pastel shades to be used in paints and give no corrosion problems even on aluminium hulls where paints containing certain other metals can cause galvanic corrosion.

The active lifetime of antifouling paints may be extended considerably if the organotin compound is incorporated into a polymeric network, e.g, in polytributyltin methacrylate or in a chloroprene rubber. The controlled release of the organotin toxicant into the water, ensuring that the toxin is leached in the correct but steady dosages from the rubber or polymer matrix, makes the antifouling coating an extremely effective one. The frequency and time spent in dry dock for cleaning vessels have been considerably reduced and a fouling-free period greater than two years has been achieved with these paints. The possibility of the period being extended to more years is under study.

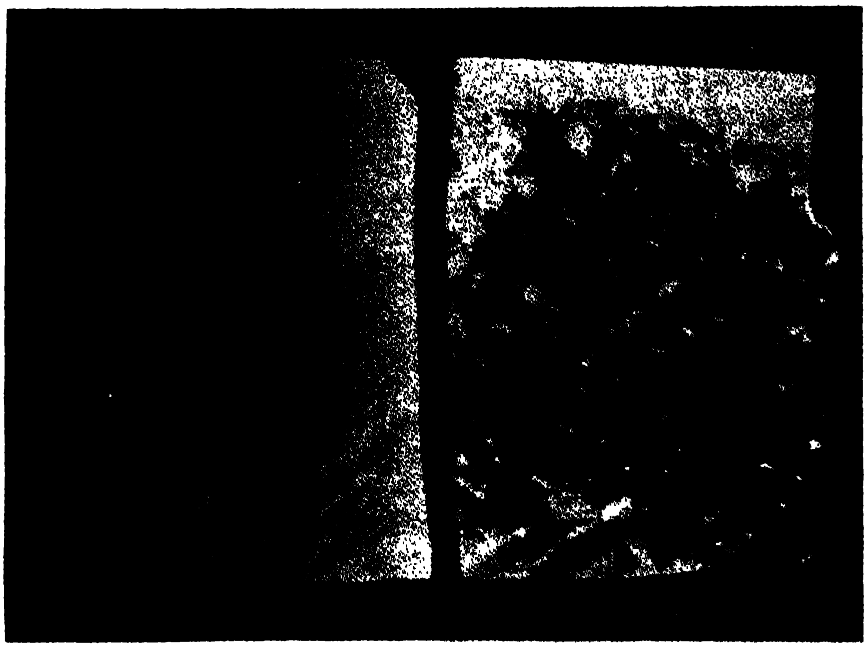

Fig. 2. Sea-water immersion tests. The panel on the left was protected with an organotin compound

Crop protection

Certain triorganotin compounds, e.g., triphenyltin hydroxide, acetate and fluoride are used in a number of agricultural formulations for controlling a variety of fungal growths which attack essential crops. Fungal diseases cause blight in potatoes, powdery mildew in sugarbeets and attack celeric, coffee, cocoa, groundnuts, bananas and rice. These fungicides are replacing those which have a tendency to inhibit growth of treated crops. Their importance in protecting foodstuffs, particularly in a developing country like India, has a vital role to play and needs serious and thorough trials by agricultural chemists.

Another important product, tricyclohexyltin hydroxide $(C_6H_{11})_3$ Sn OH, marketed by a chemical company of the U.S.A., is a miticide for protecting fruit orchards against spidermite. It is being used in Europe for protecting deciduous fruits and in the U.S.A. for citrus fruits. Residues of tin on sprayed apples and pears were found to be only 0.1 to 0.3 p.p.m. The residue existed only on the surface of the fruits and most of it could be removed by washing the fruits.

Studies of these chemicals on microbial activities in soil have shown that they have no significant impact on soil microorganisms.

Biocidal and related applications

Tributyl and triphenyltins are effective against many gram positive bacteria, including the antibiotic resistant staphylococci which are often the source of cross-infection in hospitals. Tests in which the compounds were incorporated into waxes and polishes, sprays for walls and ceilings, and in laundry washes demonstrated a considerable reduction of staphylococci. Tributyl in formulations are also important veterinary disinfectants and are used to protect textiles, socks and footwear against fungal and bacterial attack both in the industrial and the public health sectors. Small concentrations of these compounds prevent the promotion of slime and fungal growths in water and are used for this purpose in paper manufacturing mills and in closed circuit cooling water systems. Potentially important is the use of TBTO and of triphenyltin compounds in fighting the tropical Bilharzia disease. These compounds, at an extremely low (1 ppm) concentrations. are highly active against snails which act as intermediate hosts for the parasitic worms causing the disease. Tributyltin compounds are also effective as a rodent repellant and are used for impregnating cable sheaths to protect electric and telephone cables against gnawing.

Diorganotin compounds (R_2 SnX_2)

The properties of diorganotin compounds render them particularly useful in plastics industry, both as effective stabilisers in polyvinyl chlorine (PVC) and as catalysts in the production of polyurethane foams or in certain silicone elastomers.

Stabilisation of PVC

During the period 1962-1972 the world production of PVC resin went up from a mere half million tons to 7.5 million tons and is presently estimated at well over 10 million mark. The phenomenal growth of this plastic has resulted from its versatility as it can be made flexible or rigid, clear or opaque and is available in a multitude of forms and colours. However, a limitation is its tendency to degrade, accompanied by darkening of the PVC items on heating or on prolonged exposure to UV-or sun-light. This disadvantage turns out to be a credit to tin since diorganotins (e.g., dibutyl or dioctyltins) in as little as 0.5%=2% in the polymer stabilise it and maintain its clarity and impact strength. This is at present the largest single application of organotin compounds. The dioctyltin compounds having almost negligible toxicity are fast replacing corresponding butyl derivatives in this field. Though admittedly certain diorganotin stabilisers are quite expensive compared to many other less effective and cheaper stabilisers, e.g., Ca/Zn or Ba/Cd, they do impart perfect colourlessness and transparency at a very small amount.

A good scope for organotin chemicals is in PVC bottles which posses lightness in weight, clarity and safety in use (Fig. 3). In the U. K. alone, about 12000 tons of PVC are used each year for this purpose and the demand is still growing. The building industry represents the next most important outlet for PVC. The applications here are continually broadening and include floorings, cladding for building exteriors, fencing, piping and clear sheet for roofing. In the U.S.A. the National Sanitation Foundation permitted the use of organotin stabilised PVC piping for potable water while in the U.K. the Building Regulations have recognised such PVC building materials as self-extinguishing.

Catalysts for polyurethane foams

Another important use of diorganotin chemicals, dibutyltin diacetates or dilaurate, is as catalysts in the production of polyurethane foams. Only a small amount (0.4%) of these chemicals is incorporated in these foams. The size of the polyurethane market (500,000 tons/year in the U.K.; and 1 million tons/year in the USA) makes this a sizeable outlet. Prior to the use of organotins these foams had to be produced in multistage processes which can now be prepared in one stage by mixing all the reactants together.

These organotins are also used in the production of rigid foams, e.g., structural furniture frames or seamless shining polyurethane floors. In making these floors a basecoat is applied by roller, spray or trowel to a specially prepared floor surface to be covered followed by two more such urethane glaze coats. Drying with tin catalysts is 1.5 to 3 hours to give hard wearing, durable, stain and scuffing resistant floors.

Catalysts for silicones

Certain vitally important silicones with tendency of free flowing liquids or viscous gums can under the influence of some dibutyltin catalysts lead to polymers which have elastomeric properties with added toughness and flexibility. These room temperature vulcanising (RTV) silicones are resistant to extremes of temperatures and to UV radiations and many chemicals.

Some of the wide ranging uses of these organotin-containing silicones involve use in dentistry, shoe making, art casting, electronics and mould making. Intricate details can be precisely reproduced and the flexibility of the material enables the mould to be readily detached from the original. This new process allows elaborately decorated art pieces to be moulded in one operation from vinyl or other plastic materials. The moulding and cooling cycle is only of 10-15 seconds. The mould takes many thousands impressions.

Other less known but equally important and interesting application of these diorganotin derivatives lies in the use of dibutyltindilaurate in the treatment of chickens for intestinal worm infections.

Monoorganotin compounds ($RSnX_3$)

This group of organotins has so far found only restricted applications. In Germany, monobutyltin sulphide is used in restricted quantities as a non-toxic stabiliser in the manufacture of certain specific types of PVC films. Some of them are used as water repellent agents. A recent (1974) biocidal screening experiment disclosed the first example of a mono-organotin compound, phenyl stannatrane, with an exceptionally high intrinsic fungicidal activity.

Environmental effect

The effects of organotins on both man and his environment have been examined. The main hazards in handling relate to potential contact with eyes and skin. In the long term, organotin chemicals however have the advantage of producing no harmful residues since they are eventually broken down to non-toxic inorganic tin compounds (probably stannic oxide) by atmospheric degradation. This is in contrast to the organolead and organomercury derivatives which occupy somewhat similar commercial importance. Though they are also converted into inorganic salts but still remain toxic. It is therefore not surprising that the U.S. Environmental Protection Agency (E.P.A.), which cited cases of nervous system disorders all over the world, made a sweeping move and put a ban from February 1976 on the use and production of virtually all organomercury pesticides used as bactericides or fungicides. Such a ban is bound to put further demand on organotin substitutes and the production of these chemicals is sure to go up.

Conclusion

From the tremendous increase in the production of organotin chemicals over the past few years, it is evident that they have become an indispensable commodity in modern technology. Moreover, all over the world, intensive research, both fundamental and applied, is going on in the field of organotin chemistry. From such efforts there is no doubt that the present applications will be extended and new ones uncovered. It is interesting to note that an International Tin Research Council was founded as early as1932 financed by major tin ore producers of the world (Bolivia, Indonesia, Malaysia, Nigeria, Thailand and Zaire) with the object of increasing the consumption of tin. The Council's Headquarters and Laboratories are the Tin Research Institute, England, with branches in several countries.

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ELECTRON MICROSCOPE (*Continued from page* 284)

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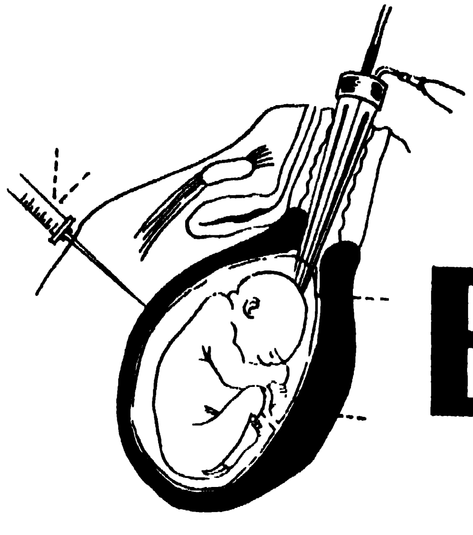
CORRIGENDUM

Ref. (i) Article **Beta-decay,** *SR* April, 1977 on page 237, Col. 3, line 40 for η/Ω *read* $\eta/2\pi$ and col. 3, line 41 for $\frac{1}{2}\ \eta/\Omega$ *read* $\frac{1}{2}\eta/\pi$

(ii) Article **Sodium-the uncommon metal from common salt,** April 1977 the author's name is R.K. Sapre and *not* R.S. Sapre as printed. Page 233, Col. 2, Para 1, Line 1 *read* reallowed *as* realloyed.



THE UNBORN BABIES NEED TO BE WATCHED

N. N. ROY CHOWDHURY
ARUP DAS

Current advances in biochemistry and technology have provided better methods for proper assessment of foetus and its environment

THE foetus, protected by the watery fluid and its 'jacket' of membranes, spends approximately 266 days in the uterus of its mother. Then, one day, painful, rhythmic, uterine contractions develop, leading to the expulsion of the conceptus from the genital tract of the mother. The new-born baby enters a new environment to accept the challenge of independent existence and ultimately adapts to this new milieu.

The placenta

During its intra-uterine life, the foetus solely depends on an organ of paramount importance, called the placenta, for its nutrition, respiration and other metabolic functions. The placenta is a disc-shaped structure, which at one surface is attached to the uterine wall of the mother. The foetal surface is attached at its centre with the umbilical cord running towards the umbilicus of the foetus. The cord contains two arteries and one vein embedded in Wharton's jelly (Fig. 1).

The placenta serves as an exchange station where, although the maternal and foetal blood streams do not directly intermingle, nutritional substances like glucose, amino acids, lipids, vitamins and minerals are transferred from the maternal side to the foetal one. Oxygen diffuses from maternal circulation to foetal circulation under the pressure gra-

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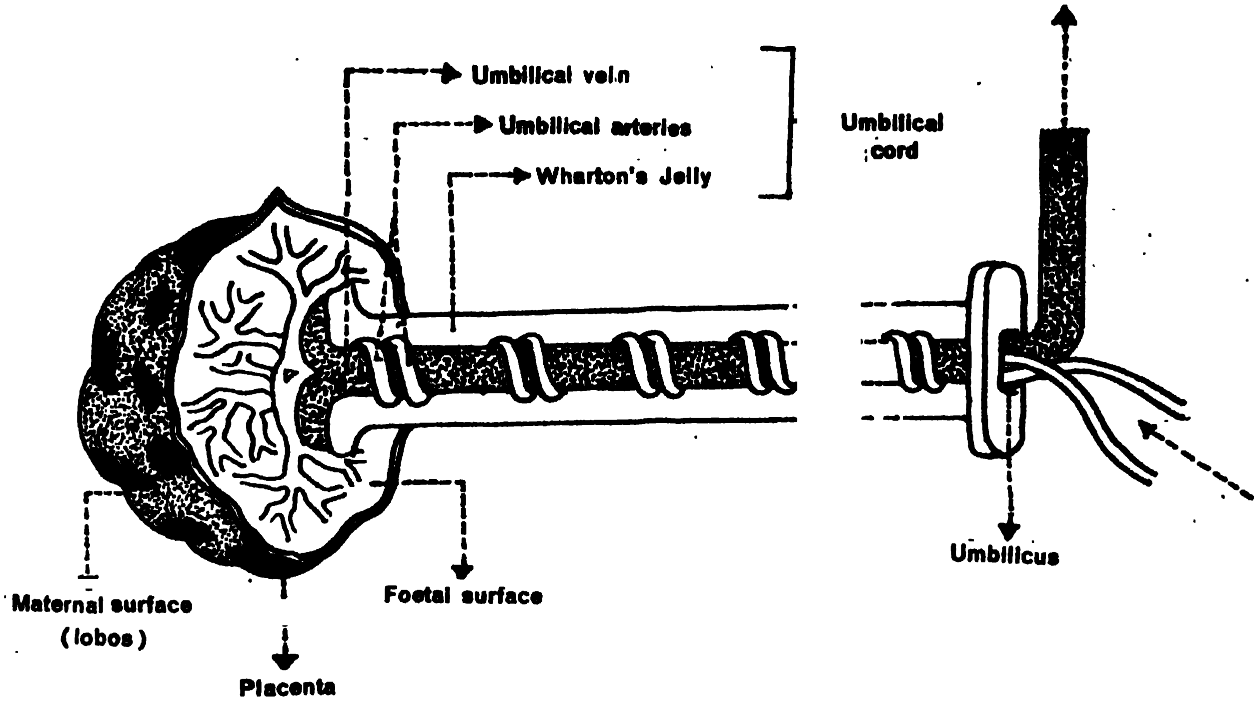


Fig. 1

dient of 35 mm of Hg, and carbon dioxide moves in the reverse direction under 7.5 mm of Hg. The placenta also behaves as an endocrine organ as it synthesizes hormones like oestrogens, progesterone, human chorionic gonadotrophin (HCG) and human placental lactogen (HPL).

As the well-being of the foetus is directly related to placental function, the foetal physiology is governed by the placental efficiency, which, in turn, is dependent on uterine blood flow and placental ultra-structure. To meet the increasing nutritional and oxygen demands of the foetus, the uterine arteries of the mother are provided with the following adaptations.

Firstly, the uterine artery is tortuous in its course so as to adapt itself to the enlargement of the uterus during pregnancy. Secondly, the branches are invaginated towards the centre of the uterine artery so that mainly the axial stream from the parent vessel is diverted through the branch (Fig. 2). As normally the blood cells run in an axial column separated from the vessel-wall by a peripheral plasmatic zone, each branch of the uterine artery receives blood rich in red blood corpuscles so as to supply increased amounts of oxygen to the foetus.

Thirdly, increased oestrogen level in maternal blood during pregnancy causes profound dilation of blood vessels. So, this results in enormous blood flow through the uterine artery. On the other hand, the foetal blood contains a special type of haemoglobin (Hb F), different from that of the adult. Hb F has a greater oxygen binding capacity than the adult haemoglobin.

Foetal distress

It has been observed that the babies with low birth weights have small placentas while the babies with high birth weights have big ones. Such a direct variation of the placental

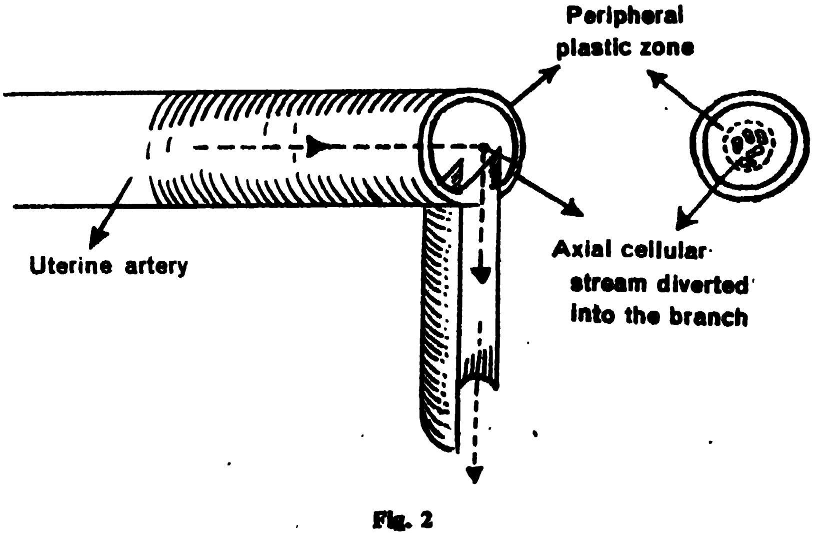


Fig. 2

weight with the weight of the new-born emphasizes the importance of placental surface area and placental blood flow in regulating foetal growth. Placental insufficiency results in retarded growth of the foetus and other anomalies.

When oxygen supply to the foetus is sufficient, glycogen is broken down to glucose, which is further metabolized to pyruvic acid through the formation of the trioses—dihydroxyacetone phosphate and phosphoglyceraldehyde. This conversion of glucose to pyruvic acid (Embden-Meyerhof pathway) occurs in the absence of oxygen. Pyruvic acid is now metabolized with the help of oxygen to carbon dioxide and water through the cirtric acid cycle. The net production per molecule of blood glucose, broken down aerobically via the Embden-Meyerhof pathway and citric acid cycle, is 38 molecules of energy-rich ATP (adenosine triphosphate). But in placental insufficiency, anaerobic breakdown of glucose via the Embden Meyerhof pathway predominates the scene and pyruvic acid is converted into lactic acid, which gradually begins to accumulate in the blood. The net production per molecule of blood glucose, under anaerobic condition are 2 molecules of ATP. The acidosis at first reflexly increases the foetal heart rate, and the change in electrolyte balance is supposed to stimulate parasympathetic nerves causing increased motility of the gut and passage of 'meconium' (foetal bowel contents). The obstetrician calls this condition 'Foetal distress.' The causes of such 'distress' may be cord compression, spastic uterus, chronic hypertension, pre-eclampsia, etc.

Table 1. Causative factors of foetal distress in relation to pregnancy and labour

Factors	*No. of cases*	*Incidence (per cent)*
Antenatal factors alone	112	48.04
Intranatal factors alone	87	37.32
Both antenatal and internatal factors	28	12.07
No pparent cause	6	2.57
Total	233	100.00

Table 2. Incidence of foetal distress in relation to socio-economic status

Social Class	*No. of cases*	*Incidence (per cent)*
Rich	12	5.14
Middle Class	72	30.88
Poor	149	63.98
Total	233	100.00

Table 3 Relationship of foetal distress with maternal age and parity

Maternal Age (in years)	*Primigravidae*	*Multiparae*	*Grande Multiparae*	*Total*
Below 20	53	—	—	53
20 to 29	91	22	12	125
30 and above	19	5	31	55
Total	163	27	43	233

Primigravidae: a women going through her first pregnancy
Multiparae: a woman who gave birth to more than 2, but than less than 5 viable babies
Grande Multiparae: a woman who gave birth to 5 or more viable babies

One of the authors, N.N. Roy Chowdhury, carried out a study of 233 cases of foetal distress admitted in Eden Hospital, Department of Obstetrics and Gynaecology, Medical College, Calcutta, during the period from April, 1965 to March, 1967. An analysis of these cases showed that in 48.04 per cent cases antenatal factors (factors involved before birth) and in 37.32 per cent cases intranatal factors (factors related to labour) were responsible for foetal distress, while 12.01 per cent foetus suffered from the brunt of both (Table 1). Antenatal factors include the socio-economic status of the mother, the maternal age and parity, duration of pregnancy and incidence of pre-eclamptic toxaemia (high blood pressure, swelling of legs and/or albumin in urine) and essential hypertension in the mother.

Malnutrition, unhygienic environment, heavy physical work, worried

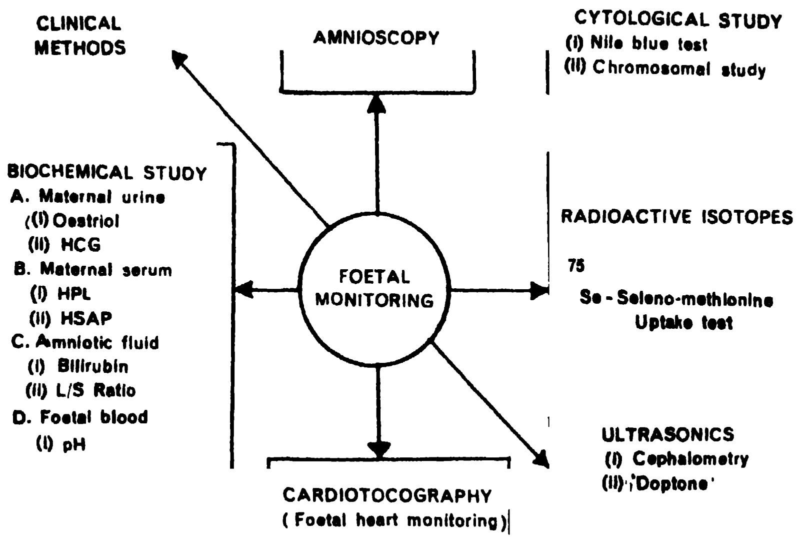


Fig. 3

and anxious state of mind in mothers of low income-group are possibly the causes of high incidence of foetal distress among the poor (Table 2). Babies of these mothers may be less able to withstand trauma during labour and delivery. The study also revealed that a woman going through her first pregnancy at a higher age (elderly primigravidae) is particularly prone to develop foetal distress, the incidence being 42.10 per cent even when there were no other associated factors (Table 3). The incidence of foetal distress at 43rd week of gestation is 4 times higher than at 40 weeks. Nearly 70% of the pre-eclamptic toxaemia cases suffered from foetal distress even when they were not complicated by any other factor. With increasing length of labour due to uterine inertia the incidence of foetal distress rises steadily.

From an analysis of the above causes of foetal distress, it may be postulated that vigilant supervision of the pregnant woman throughout pregnancy and labour, improvement of socio-economic status, avoidance of heavy physical work, worries and anxious state of mind in mothers can save many babies dying from premature death. Prevention of pre-eclamptic toxaemia and avoidance of post-maturity (pregnancy continuing for more than 42 weeks) are also essential for the same reason.

It must be remembered that the birth of a live-born baby is not necessarily an indication of good obstetrics. A baby subjected to diminised supply of oxygen during labour may

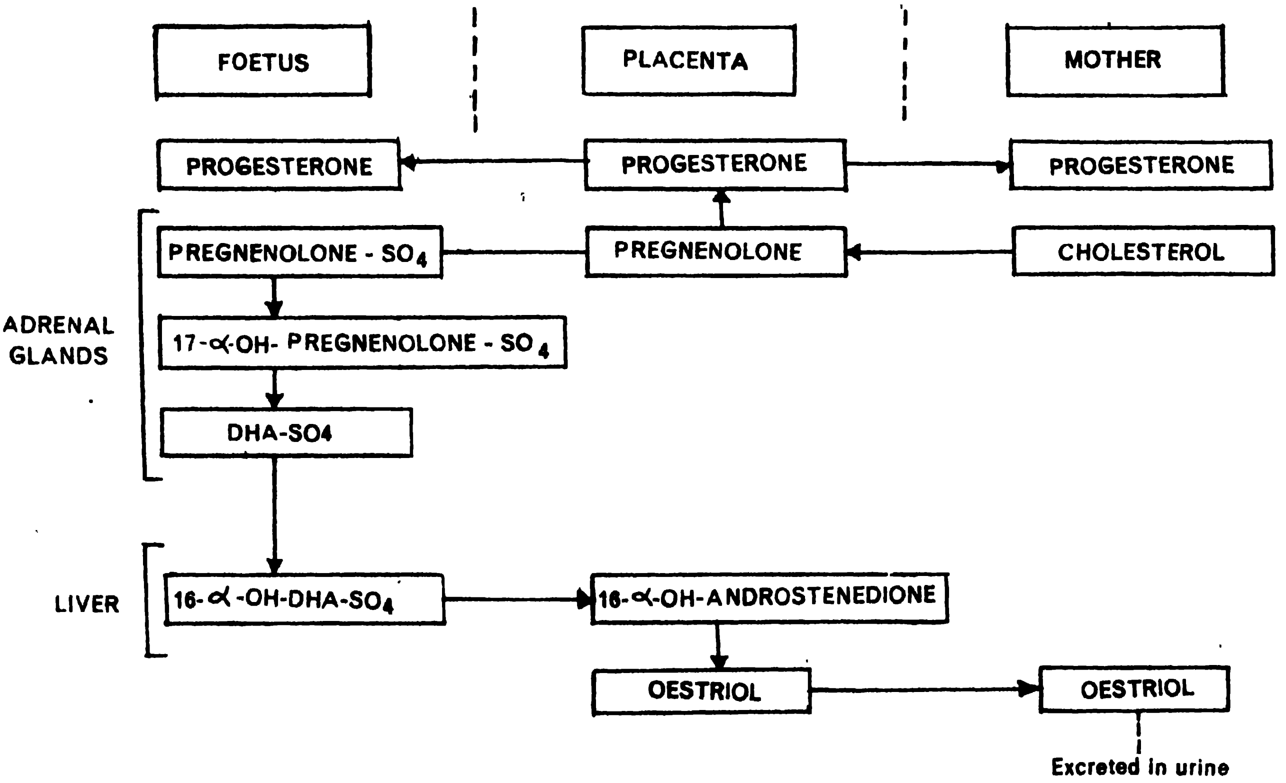


Fig. 4. Oestiol synthesis by "Foetoplacental units"

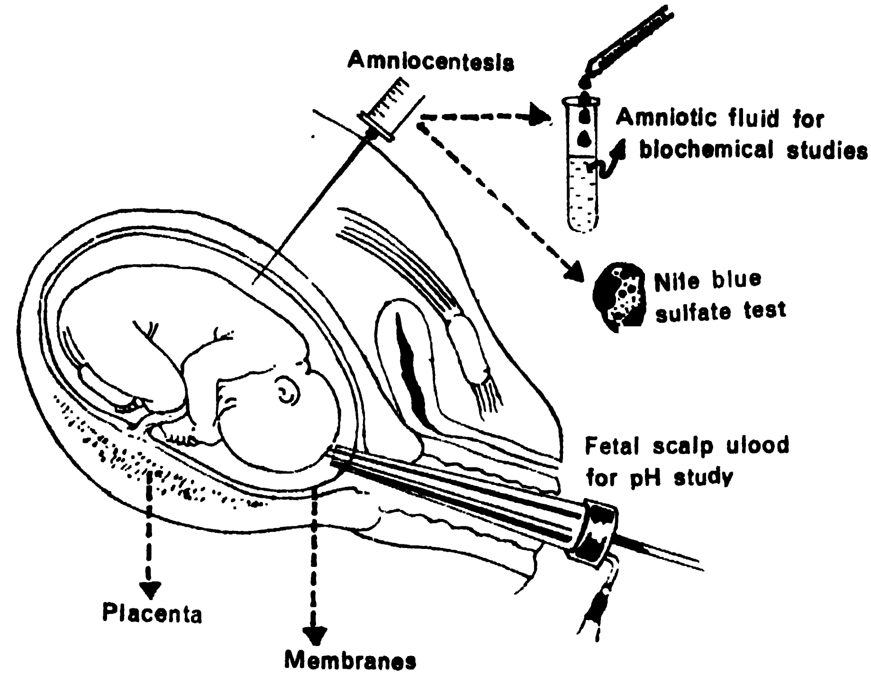

Amniocentesis
Amniotic fluid for biochemical studies
Nile blue sulfate test
Fetal scalp ulood for pH study
Placenta
Membranes

Fig. 5.

become mentally crippled afterwards. So foetal distress should be guarded against with the utmost precision.

Clinical diagnosis

The clinician still follows the traditional methods to diagnose foetal distress. Obviously this is a matter of personal choice. If the foetal heart sound, as heard with the stethoscope, shows any abnormality, specially a rate above 160 per minuite, and the vaginal examination shows passage of meconium-stained amniotic fluid, one may arrive at the diagnosis of foetal distress. Nowadays obstetrician however does not wholly rely on these traditional methods. Current advances in biochemistry and technology have provided him with better methods for proper assessment of the foetus and its environment. Such investigations can help him in monitoring the foetal growth and maturity and also in early recognition of 'at risk' foetuses so as to reduce the number of stillbirths and the first week deaths of babies by taking immediate measures (Fig. 3).

As the foetus is enclosed in a special environment, one has to study it without disturbing the pregnancy and without causing any harm to the foetus or the mother. A major breakthrough in this field came when A. Alberto Hodari and Lorna Thomas succeeded in 1969 in devising an intrauterine surgical technique for removal of foetal kidneys in dogs without any loss of amniotic fluid during operation. Now one can be optimistic that in the near future such operations will be performed on human foetuses also.

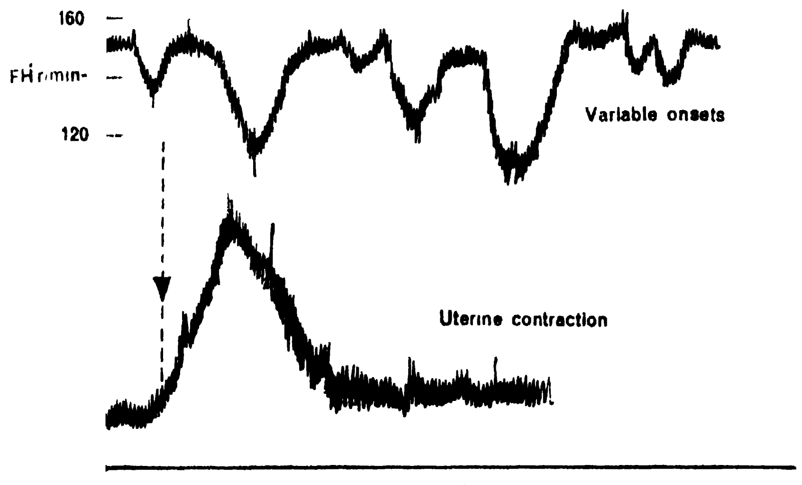
Endocrine and enzyme studies

Currently the widely used method for assessment of placental function and the general well-being of the foetus is the estimation of oestriol level in the 24 hours urine specimens of the mother, at intervals, during late pregnancy. The oestriol is the metabolic end-product of the major secreted oestrogen hormone, oestradiol. The placenta lacks some of the enzymes necessary for the intermediate steps in the synthetic pathway of oestriol. The cholesterol reaching the placenta from maternal circulation is converted into pregnenoline, which is transferred to the foetus and transformed into dehydroepiandrosterone sulphate by the foetal adreno-cortical enzymes. It is further hydrozylated to 16—α—OH-DHA—sulphate in the foetal liver. The placenta then takes over the final steps of oestriol synthesis from 16-α-OH-DHA-sulphate and the oestriol is then excreted into the mother's urine (Fig. 4).

So, the oestriol production is due to the combined action of the foetus and the placenta as a whole. It has given birth to a concept of 'foeto-placental unit.' The quantitative measurement of urinary oestriol level of the mother is hence an indicator of functions of both, the foetus and the placenta. Repeated oestriol level screening is essential, otherwise a single isolated reading is of little help in diagnosing foetal distress. In cases of retarded intrauterine growth, haemorrhage from the genital tract after 28th week of pregnancy, but before the birth of baby. maternal hypertension, urinary oestriol levels are low and thus demand a prompt necessary treatment.

Human chorionic gonadotrophin (HGG) is a hormone of the placenta which can be detected in the mother's urine from the fifth week of pregnancy. The level of HCG rises to a peak (30,000 IU/24 hrs.) between the 8th and 12th weeks and then falls to a low level (5000 I U/24 hrs.) which is maintained throughout the rest of pregnancy. Repeated urinary HCG assay provides valuable information about the placenta, specially in cases of threatened abortion where a low level of urinary HCG against a specific gestational week indicates a bad prognosis.

Another placental hormone, human chorionic somatomammotrophin (or human placental lactogen, HPL), can be demonstrated

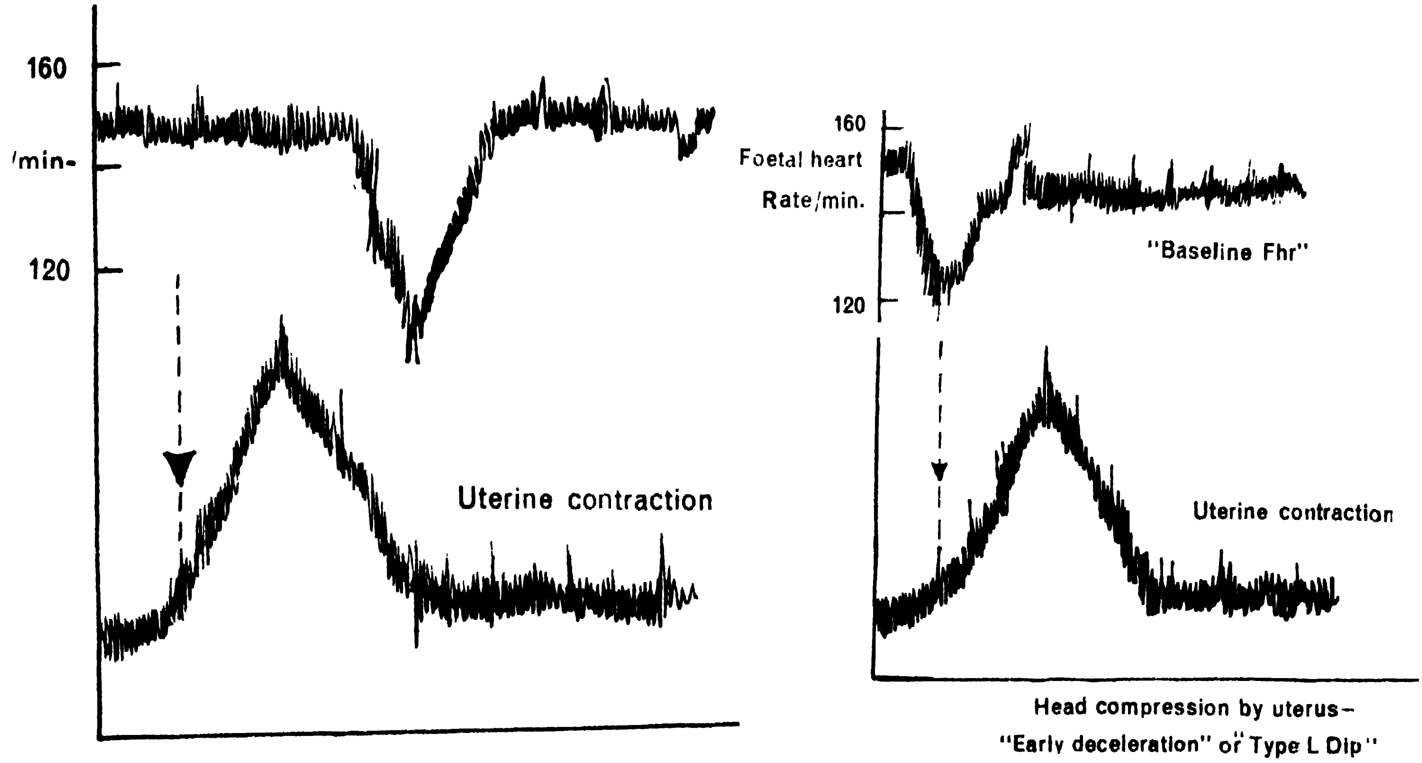


Umbilical cord compression –
"Variable deceleration" or "Type O Dip"

Fig. 6. Foetal heart monitoring—graphic record

in the mother's serum by radioimmuno-assay techniques from the 6th week of pregnancy onwards. The level of HPL in maternal serum gradually rises throughout pregnancy reaching 6-8 μg/ml during the last 4 weeks. A very low level after 35 weeks points to placental insufficiency.

A test simpler and quicker than hormone assays is currently under trial in many laboratories. It involves repeated estimation of heat-stable alkaline phosphatase enzyme (HSAP) in maternal serum. This enzyme, produced by the placenta, is heat-stable upto 65 °C, while other phosphatases become inactive at 56°C. The level of HSAP gradually increases with the increase in gestational period, and any abnormal high or



Utero-placental insufficiency
" Delayed deceleration " or " Type 2 Dip "

Head compression by uterus–
"Early deceleration" or Type L Dip"

Fig. 7. Foetal heart monitoring-graphic records

low level of HSAP suggests placental dysfunction.

Amniocentesis

The foetus grows in a watery alkaline fluid, called amniotic fluid, contained within a membranous sac. Diagnostic amniocentesis, which involves aspiration of a small quantity of amniotic fluid from the amniotic sac by inserting a needle through the abdominal wall and the uterine wall, has revolutionized obstetrical management in recent years. After abdominal palpation, the proper site for puncture is chosen and under aseptic condition a local anaesthetic is infiltrated into the skin at that site. With the help of a needle and a syringe, a sample of amniotic fluid is drawn for biochemical, cytological and chromosomal studies (Fig. 5). This procedure usually does not cause any damage either to the foetus or to the mother, although rarely there lies the risk of damaging the placenta or the blood vessels running in the umbilical cord.

When the blood group of the mother is Rh-negative and that of the foetus is Rh-positive, it gives rise to a condition called Rhesus incompatibility. A few foetal red blood corpuscles 'leak' into the maternal circulation, specially at the time of placental separation. If the ABO blood groups of the mother and foetus are now such that there will be no cross reaction (ABO compatible), these foetal RBC will stimulate antibody production in the mother's blood. These antibodies on entry into another Rh-positive foetus during next pregnancy, will cause rupture of the foetal RBCs with the release of free haemoglobin in the blood. Excessive breakdown of haemoglobin in such cases will result in increased production of bilirubin which will ultimately stain the amniotic fluid. In Rh-negative women, who had a still birth or a pale oedamatous baby (*hydrops foetalis*) or a baby who became jaundiced within a few hours of birth (*icterus gravis*), the amniocentesis should be performed at 24-30 weeks and repeated fortnightly. The bilirubin level can be determined by measuring the optical density of the amniotic fluid at a wavelength of 450 $m\mu$ in a spectrophotometer. When bilirubin of the amniotic fluid is high (as shown in the spectral absorption curve), the obstetrician can immediately start intrauterine blood transfusion to the foetus. This surgical intervention during pregnancy is a big step towards intrauterine foetal surgery.

The alveoli of the foetal lungs secrete some liquid substances, mainly lecithin (L) and sphingomyelin (S) into the amniotic fluid. Normally after the birth, molecules of L, called surfactant, spread over the alveolar epithelium at the air-fluid interface and coalesce together during expiration, when the alveolar size decreases. And lecithin thus prevents the complete collapse of the alveoli by lowering their surface tension. With advancing weeks of gestation, amounts of L and S proportionately increase in the amniotic fluid. But at 35 weeks L/S ratio suddenly changes from 1:1 to 2:1, which indicates that lungs are functionally mature. The stress due to deficiency of oxygen results in acidosis and a fall in pH level of the foetal blood. At a pH of 7.0—7.2, the methyl transferase pathway for synthesis of lecithin is inhibited resulting in deficiency of the surface-active alveolar lecithin which causes Respiratory Distress Syndrome (RDS) in the newborn. So, if during late weeks of pregnancy the L/S ratio of the liquor sample is found to be less than 2:1, it indicates deficiency of lecithin and hence foetal lung immaturity. With L/S ratios of less than 1.5, the incidence of Respiratory Distress Syndrome has been found to be 100%.

The foetal skin cells shed into the amniotic fluid are stained by the nile blue sulphate test to detect foetal maturity; the test involves the use of 4 drops of the liquor and 4 drops of 0.1% of nile blue sulphate incubated at 37 C for 3 minutes. One drop of this mixture is examined microscopically, and the percentage of the orange-stained lipid containing squamous cells' is calculated. Normally, from 36 weeks onwards the number of the lipid cells increases, and a concentration of lipid cell more than 50% suggests that the foetus is mature.

Amniocentesis is employed in many centres for diagnosis of chromosomal anomalies in a child before birth and for sex determination of the foetus suspected for hereditary sex-linked diseases. Some of the 'inborn errors of metabolism' (due to enzyme deficiency) can be diagnosed *in utero* by assessing the specific enzyme activity in the amniotic fluid cells.

Amnioscopy

An amnioscope is a metallic tube with an illumination source and can be introduced into the cervical canal for visualizing the *liquor amnii* to detect presence of any meconium. Meconium staining of amniotic fluid as revealed by amnioscopy, suggests that the foetus is suffering from diminished supply of oxygen (foetal hypoxia). Meconium, added to the amniotic fluid, provides a good culture medium for bacteria like *Escherichia coli* and *Listeria monocytogenes* and exposes the foetus to infection. Amnioscopy can be carried out in five minutes and may guide the obstetrician whether the foetus should be delivered immediately or not.

Ultrasound

Among the sophisticated techniques used in obstetrics, one which has caused dramatic impact is the use of ultra sound. The sound waves beyond the normal range of audibility (with frequency more than 20,000 cycles per second) are called ultrasounds. They can be used (1) to measure the transverse diameter between the two lateral eminences of the foetal skull, called biparietal diameter (Cephalometry), (2) to locate the site of attachment of the placenta, (3) to diagnose foetal abnormality, and (4) to monitor the foetal heart activity (Doppler Flowmeter or DOPTONE).

In cephalometry, the ultrasonic beam, reflected back from the sides of the foetal skull, is graphically depicted on the cathode-ray screen. Repeated measurements of the biparietal diameter of the foetal skull will guide in assessing foetal growth and maturity. The 'DOPTONE' sends the ultrasonic beam towards the moving foetal heart. As the foetal heart surface alternately approaches and retreats from the mother's abdominal surface, the frequency of the reflected beam alters according to the Doppler principle. It can detect the foetal heart sound as early as in the 12th week of pregnancy. Any increase in the foetal heart rate (over 160 per minute) reflects the response of the foetus to a hypoxic condition. So far ultrasound for diagnostic purposes has been found to be without any risk, although in a very few cases chromosome breakages in the foetus have been reported.

Foetal heart monitoring

Recently, continuous foetal heart monitoring during labour is suggested to be one of the most important methods for detecting 'foetal distress'. This method is too expensive for our country and then the correct interpretation of the graphical records is also very difficult. The same instrument simultaneously records the foetal heart rate (FHR) together with the uterine contractile activity (tocograph). During normal labour, the baseline FHR between two uterine contractions is 120 to 160 per minute. In cases of head compression by uterus, the FHR decelerates just before each uterine contraction (early deceleration or Type I Dip). In uteroplacental insufficiency the FHR falls within 30 seconds of the onset of each contraction (delayed deceleration or Type 2 Dip). While the above cases show rhythmical alteration of the FHR in relation to the onset and duration of the uterine contractions, the FHR in cases of umbilical cord compression, decreases irregularly with variable onsets without a definite relationship with the contraction of theuterus (variable deceleration—Type O Dip). A prolonged variation of the FHR for more than 10 minutes positively suggests foetal hypoxia (Fig. 6).

Conclusion

Most of the methods mentioned above are not in practice in our country as they need highly sophisticated electronic equipment and laboratory facilities. Again, a single test is of limited help in assessing foetal distress and maturity. As, for example, R. M. Rome, S. C. Simmons, M. Bearne and D. Watson (Windor and Slough Obstetric Unit, Upton Hospital, Slough, Berkshire, UK) in 1976 have stressed more upon the importance of the combined use of L/S ratio, amniotic fluid creatinine concentration and nile blue sulfate test than on the use of single test of L/S ratio for an accurate assessment of foetal lung maturity. The maturational status of the lungs is now thought to be an important parameter of foetal maturity. It is because lungs are the most vital organs needed for adaptation to the extrauterine environment. The clinical findings and the biochemical information, supported by foetal heart monitoring and foetal scalp blood pH study, if available, should be analysed as a whole before coming to a positive conclusion about the well-being of the foetus. The estimation of foetal maturity will help obstetrician to establish the optimal time for delivery in "high-risk pregnancy" conditions.

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THE SHREWS
ONLY SMELL BAD

People react badly to shrews, because of their unpleasant body smell and likeness to rats in appearance. The truth is they are a helpful animal

ARUNA MOHAN

THE shrew or the 'chuchunder' has been the object of much legend and superstition. In the first century A. D., the presence of venom in shrew was established. Galen, the Greek doctor of Emperor Marcus Aurelius, had a belief that venom of the shrew could even kill a man. However, in those days people used to believe that shrews in the house would ward off evil spirits. The North American Eskimos always avoided shrews, for they had the feeling that crossing a shrew's trail brought bad luck.

The shrew is an insectivore. The insectivores are so named not because they necessarily eat insects, but because their teeth are most suitable for this activity. The shrews are the smallest mammals. They are common almost everywhere, though are seen rarely because of their small size and nocturnal habits. The shrew is one of the most primitive placental mammals and, is close to the stem from which man arose.

The shrews are small in size, have short legs and pointed nose. They look like mouse. They belong to the insectivorous family soricidae; which is divided into three sub-families: soricinae (the red toothed shrews), seutisoricinae (the armored shrews) and crocidurinae (white toothed shrews). These three sub-families have 24 genera and 200 species.

A shrew has numerous sharp teeth. It resembles in size and dentition to some of the earliest mammals whose fossils date back to 200 million years.

The shrews are of special interest for several reasons. They are smallest mammals and their metabolic rate is the highest of all animals in this group. The masked shrew is reported to breathe 850 times per minute and has a pulse rate of 800 beats. A poisonous substance in the saliva helps the shrew in the capture of mice and other preys. This poisonous substance is produced by submaxillary glands and is capable of killing a mouse.

The musk shrew (*Suncus murinus*) frequents our homes at night in search of insects like cockroaches and crickets on which they feed. It is commonly confused with the rat, but can be distinguished by its pointed snout and depressed ears. A strong musky odour is emitted by the animal due to the secretion of the musk glands.

The shrews also interest man because they resemble animals from which many mammalian groups have evolved. The ancestors of lemurs, apes, monkeys and man himself are believed to have been somewhat like shrews. The tree shrews are considered to be the most primitive of primates.

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Order Insectivora: characters

The shrews, hedgehogs and moles belong to the order Insectivora. They are small in size. The snout is usually long and tapered. The feet have five toes with claws. The teeth are sharp and pointed.

They are considered primitive and are eutherians with a low grade of organization. They are nocturnal or burrowing in habit. The auditary region is unprotected by a bulla. The uterus is bicornuate, i.e., with two horns (uterus duplex). The brain is small without cerebral convolutions.

The insectivores may be considered as the nearest ally of the stock of small cretaceous mammals from which arose, by a process of divergent evolution, different types of present day mammals. It is true that they have become specialized in several respects :

(i) reduction of zygomatic arch in some forms (hedgehogs) and even its absence in others (shrews)

(ii) weak pelvic girdle

(iii) occasional absence of pubic symphysis e.g. shrews

(iv) the well known spines of hedgehogs

(v) modifications of the limbs and girdles for digging in the fossorial forms like moles.

(vi) secondary elongation of snout to form a long pointed muzzle as in moles and shrews etc.

However, they share many primitive features with the metatheria and the cretaceous mammals both in the skeleton and in the anatomy of their soft parts. The skull is elongated and tubular.

The insectivores are nocturnal save the tree shrews (Fam. Tupaiidae). They are diurnal.

Distribution

Barring Australia and polar regions, shrews are found throughout the world. In forests, as in other parts of world, shrews are the most orvacious of the insect-eating mammals. Day and night, all the year round, they have short periods of intense activity separated by longer rests.

The insectivores are widely distributed, but are not found in Australian region. Geologically, the insectivores made their first appearance in the lower Eocane of Europe and North America.

A large number of insectivores are cursorial (running), a few like the moles are fossorial (burrowing), myogale (South Europe) and potamogale (West Africa) are aquatic and some like the tree shrews are arboreal.

The habitats of shrews vary. Most species prefer cool and moist regions but others flourish in hot, dry deserts. Some like to live in cold climates, burrowing under the snow in winter. The shrews are small in size ranging in length from 1½ inches to 5 inches in body length. That is why the temperature and water evaporation have much to do with their choice of home sites.

Habits

Habits of shrews also vary. Some hunt in water for their food; others on land. Some which are small in size raid beehives through the entrances made by bees.

All shrews move about in short, fast runs, constantly uttering squawks, squeaks, twitters, whispers, and trills. In China, the *Suncus* shrews are called money shrews because their chatter sounds like the clinking of coins. The white toothed shrew of Southern Europe and North Africa has a grey breast but its cry sounds like chirpings of robins. In Italy it is called the red-breasted shrew.

Shrews are an aggressive animal. Male shrews fight each other and the one which wins may then dine on the loser. Inspite of their aggressiveness, they are very sensitive and delicate. The heart beat of the frightened shrew can rise to 1,200 per minute. The shrews do not live long. The average life span of a shrew is less than one year.

The common european shrew (*Sorex araneus*)

It is also found in Europe and Asia. It has a long head and small eyes. The ears are very short and scarcely visible. The feet are 5-toed. The tail is 2 inches in length. The body length is 2¾ inches. The muzzle ends in a mobile snout with whiskers. The body is covered by blackish or grayish brown coat on top, reddish streakings on the flanks and yellowish white underneath. This shrew, though small in size, can attack a rat larger than itself. It is a good borrower and can also climb.

The old world water shrew (*Neomys fodiens*)

It is 4 inches long. Its tail and the feet are covered by swimming hairs which are three inches long. The tail serves as a keel when the animal swims. These shrews have a thin body, elongated muzzles and tiny ears which are hidden in the hair.

The water shrew is found in most parts of Europe. It feeds on small water animals, mollusks, crustaceans, insects, fish, frogs and small birds.

The water shrew spends day hours in a den made near the banks of the water course. The den will have one entrance by tunnel from the ground surface and another under water. The den is linked by grass and is thoroughly protected. In this den, the female gives birth to litters of six to eight, several times during the spring and summer months.

The black shrew (*Soriculus nigrescens*)

It is found at the heights of 2½

miles in Sikkim and Nepal. It is about 2¾ inches in length with a tail not more than an inch.

The genus *soriculus* consists of six species that live on the southern slopes of the Himalayas. These shrews are related to the northern and Pacific water shrews.

The armored shrews

The armored shrews of the subfamily scutisoricinae consist of a single genus, *Scutisorex* which has two species, *S. congicus* (the conge armored shrew) and *S. somereni* (the Uganda armored shrew). These shrews have complex and strong skeletons, with elaborate interlocking vertebrae. They can easily support the weight up to 160 pounds without much harmt o themselves.

The lesser white-toothed etruscan shrew (*Suncus etruscus*)

It is the smallest mammal on the earth. It is 2 to 3 inches long. It never weighs more than 1/14 ounces. It has a tiny, pink snout and thin red feet. It never digs dens. It lives in southern Europe, Asia and Africa.

The Indian musk shrews (*Suncus murinus*) (Fig. 1)

The musk shrew, *Suncus' murinus*, belongs to the family Soricidae. This animal is widely distributed in south and south-east Asia. It is slightly smaller than' the house rat. The snout is pointed and projects beyond the lower lip. Eyes are extremely small and weak. The snout, pinna, limbs and tail appear pink due to sparse distribution of hair in these regions. They are short legged mammals covered with a dense fur. A pair of scent glands are found on the flanks in both sexes. These glands produce the unpleasant odour so characteristic of the animal. The male is usually larger than the female. The root of the tail is swollen in the male, but constricted in the female.

The reproductive habits of the musk shrew have been studied under laboratory conditions. It is a non-seasonal breeder. The male and the female live apart, except at the time of breeding. The gestation period is about 30 days. The litter size is usually 1-4. The *Suncus* it weaned at 17 days and becomes sexually mature about two weeks later. There is post-partum oestrus and hence fertile mating takes place if the female has access to a male. Hence pregnant and concurrently lactating females are sometimes met with.

Food habits

They hunt feverishly for insects in the undergrowth of leaf litter beneath the conifers.

The musk shrew is a frequent visitor to the kitchen and is a domestic pest which thrives on kitchen waste and insects. However, unlike the rat, it causes very little damage to food materials. They are the little mammals with a voracious appetite. They loose heat quickly. So they need more food in relation to their body weight than larger animals do. They eat frequently and most of them consume upto three times their weight when food is plentiful. The shrews' regular diet is beetles, spiders and larvae, supplemented in winter by the pupae of insects which they dig out of the ground. In the laboratory, musk shrews (*Suncus Murinus*) were fed with live frogs, meat, rice and milk.

The shrews have a higher metabolic rate than any other mammal and are unable to survive more than ten hours without food. In general they live on insects and worms. They relish cockroaches and crickets.

Eonomic importance

The body of a shrew is covered with dense fur. The fur is used for making coats. A pair of scent glands is found in the musk shrew. These glands produce an unpleasant odour. The odour is emitted especially during mating or when the animal is disturbed or when it is subjected to pain, stress or fear. In nature this odour is believed to save them from being eaten by animals. They are however the prey of owls, storks and vipers. Since they feed on cockroaches, crickets and other insects, they help us in reducing the number of harmful insects.

We know that rats spread plague. Unlike rats, the shrew does not spread any infection or disease. The shrews do not cause much damage to the food material. Sometimes shrew feeds on pupae of insects after digging. Thus they help to increase fertility of the soil. The poisonous saliva of shrew can even kill a mouse.

Man takes interest in shrews for various reasons. Its saliva contains a venom. This venom is not as powerful as the venom of poisonous snakes but can cause a human victim much pain and discomfort. The shrews are most welcome on farms. They help in holding down insect and rodent population. Some species of shrews eat insects twice their own weight every day.

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SCIENCE SPECTRUM

Water outside earth's galaxy detected

ACCORDING to an announcement from the Max Planck Institute of Astronomy, the presence of water outside the earth's galaxy has been detected for the first time, indicating the possibility of life in outer space. The astronomers from the United States, France and West Germany found rotating molecules of water with the help of the 108-foot Effelsberg radio telescope, the largest portable radio telescope in the world. The Institute said that the water molecules had a density of one for every 10 cubic centimeters and were situated on the edge of nebula "IC-133", 2.2 million light years away, or about one trillion times further than the earth from the sun.

The discovery suggests the possibility that other solar systems may exist with the same physical conditions as ours with planets and stars also formed by the condensation of dust and gas with the same type of life span. It is expected that astronomers would look for water vapour in more galaxies.

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Metal rectifiers

THE direct current is now superseded by the alternating current in view of the latter's special advantages. The preponderance of A.C. over D.C., however, does not always hold, for in a number of applications such as electric traction systems, electrochemical processes, printing work, movie projectors, electronic instrumentation (radio and TV receivers) and so forth, D.C. is important. D.C. is preferable in some of these devices. and in others it cannot be substituted. As the supply from power stations is A.C. in three phases, D.C. operated appliances have to do the extra job of converting alternating current into direct current. And the device which accomplishes this task is called rectifier. Obviously, such a device must satisfy a basic condition—it must be endowed with the property of unilateral conduction. Since a multiplicity of devices fulfil this criterion, a wide variety of rectifiers are available. Notable are the vacuum type and gas-and vapour-filled diodes based on thermionic emission, the mercury arc pool-cathode rectifiers, the semiconductor junction rectifiers, the electrolytic rectifiers and the metal rectifier A.C. to D.C. (and D.C. to A.C.) conversion can also be conveniently achieved with the rotary convertors. Each rectifier has its own mode of operation, its own merits and demerits. which may be used depending on the situation at hand.

A simple category of rectifiers is represented by the Metal Rectifiers, also called Barrier layer rectifiers or cells, based on the principle that a barrier layer between some specific combinations of metallic substance—usually a conductor-semiconductor pair—resists the flow of current in one direction but is ineffective in the other direction. This means that the barrier layer presents an almost infinite resistance to current flow in the inverse portion of the cycle and almost zero resistance in the forward portion. The adverb 'almost' is used because there is no device which blocks or lets through current (in a particular direction) completely—no rectifier is perfect,

Our knowledge of the barrier layer is meagre. However, it must be noted that the contact between the pair of substances used is of such close nature that the work function of the metal is at least partly lowered; the free electrons of the metal can therefore easily diffuse into the other participant involved.

Copper oxide and selenium rectifiers

A metal rectifier, frequently used, is the copper-cuprous oxide recti-

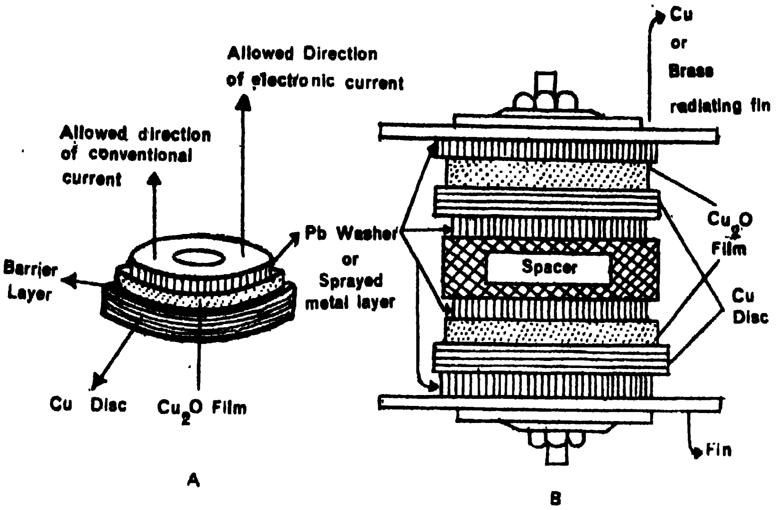
Allowed Direction of electronic current
Allowed direction of conventional current
Barrier Layer
Cu Disc
Cu_2O Film
A
Pb Washer or Sprayed metal layer
Spacer
Cu or Brass radiating fin
Cu_2O Film
Cu Disc
Fin
B

Fig. 1

fier, Fig. 1 (A). A rectifier element of this type is built up of a copper sheet or disc. One of the surfaces of the copper disc is subjected to a thermal treatment. This accumulates, by oxidation, a thin deposit in the form of a film on that surface. The deposit is composed of reddish brown cuprous oxide, Cu_2O. The oxide layer is scraped from a small portion where a wire is introduced (not shown in Figure) and connected to the copper disc. Further, as cuprous oxide has a high resistivity, the oxide layer is covered with a washer of soft lead. The primary objective of covering the oxide with a lead washer is to ensure a good electrical contact. A thin film of metal formed by spraying also suffices.

Another metal rectifier of wide commercial use is the selenium rectifier (Fig. 2). It is made up of a steel disc mantled on one side with a fine coating of selenium. The selenium coating is covered with a thin layer of a binary alloy in which the constituent metals are tin and cadmium.

The barrier layer in a rectifier of the first type is formed between the surface of the copper disc and oxide film. The obstruction layer is formed in a rectifier, of the second type between the selenium surface and the alloy film. In the copper oxide rectifier, the electrons can traverse the path copper→oxide but are forbidden to diffuse the reverse way. Likewise, the electrons in the selenium rectifier can tread the path alloy→steel but are not permitted to move from steel to alloy. The copper disc in the former rectifier and the alloy film in the latter may be considered as the counterparts of a diode's cathode. One must not however forget that, in either case, a fraction of electrons does not conform to the above rule.

A metal rectifier, of whatever type it may be, symbolized in a circuit-diagram by the notation is given in Fig. 3.

Static characteristic

A pertinent graph for a rectifier is its static characteristic. The static characteristic summarizes the relationship between the current in the rectifier and the terminal voltage. It correlates the instantaneous values of current and potential difference in a rectifier circuit containing no load resistance. Static characteristics for the copper oxide and selenium rectifiers are found to be identical in shape. Needless to say that, the characteristics will be non-linear. In Fig. 4 are sketched the volt-ampere curves, under zero load condition, for the forward and reverse operations of a typical metal rectifier. The curves resemble somewhat the familiar curves for semi-conductor junction diodes. Useful information can be obtained from the volt-ampere graphs. Reciprocal of the gradient of the forward characteristic at a point gives the forward resistance of the rectifier at the point. It is clear from the figure that the tangents at different points of the forward curve have different inclinations to the voltage-axis. The forward resistance is a function of the applied voltage. As progressively increasing forward voltages are impressed across a metal rectifier, a slow increase in current is observed in the initial stages. If the process is continued, a stage comes when a small incre-

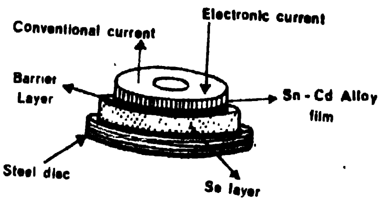

Fig. 2

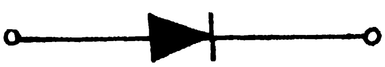

Fig. 3

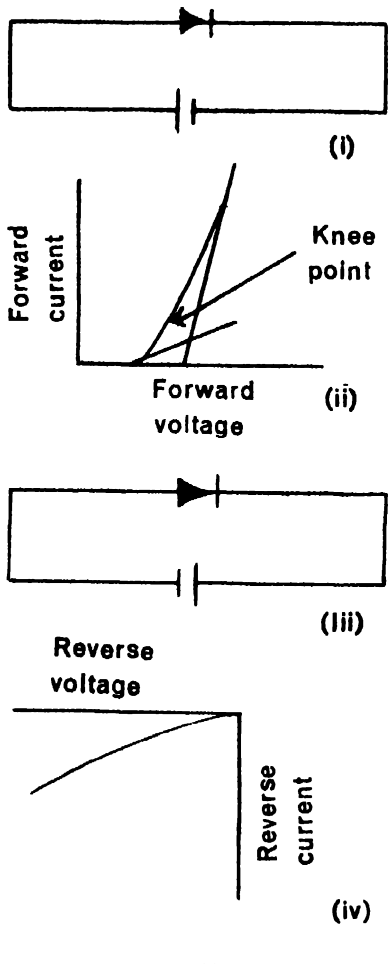

Fig. 4

ment in potential difference causes a sudden steep rise in current. The abrupt change in current takes place at the voltage at which the volt-ampere graph bends. The approximate forward voltage causing the sharp swing in current may be termed knee voltage if junction-diode nomenclature is extended to metal rectifiers. The sharp swing occurs in a copper oxide rectifier with forward voltages in the neighbourhood of 0.2 volt. The same happens in a selenium rectifier at a little higher voltage. The knee voltages are lower than the corresponding values for germanium diodes (0.6–0.8 volt), but are of the same order as the values for silicon diodes (0.2–0.3 volt). Though a selenium rectifier introduces a higher potential drop, it has a smaller forward resistance as compared to the copper oxide rectifier and hence a larger rectification efficiency—(direct power across the output/A.C. input power) 100%.

In analogy to the forward characteristic, the reverse curve also exhibits a varying resistance. An important term relating to the back operation of a rectifier is the peak-inverse-voltage rating. The term warrants special attention here. The peak-inverse-voltage rating of a rectifier is the crest value of the voltage that the device can withstand in the non-conducting direction. Since the rating gives the maximum reverse voltage that the rectifier can forbear, it serves as an index of the rectifier's tolerance in the inverse direction. Bearing this in mind, the rated peak-inverse-voltage of a rectifier should not be exceeded. A single element of copper oxide rectifier is readily damaged on applying a reverse potential difference above 10 volts. In contrast, the upper safety limit for the singly operated selenium rectifier falls around 30 volts. For comparison, the values for junction diodes lie in the range 25-30 volts. Because of the low peak-inverse-potential rating, a number of copper oxide rectifier elements, Fig. 1 (B), are often joined in series through the intervening lead washers. Cooling fins of brass or copper are also included. In the condition where copper oxide rectifier is not essential, a relatively smaller number of selenium rectifier elements may be substituted.

Full-wave rectification

Two common circuits used for full-wave or biphase rectification are: (a) the centrally tapped transformer circuit, Fig. 5 (A), and (b) the bridge circuit, Fig. 5 (B).

Now refer to Fig. 5 (A). During the half-cycle in which the potential difference polarities in the secondary winding of the transformer are as indicated, rectifier–1 admits of a current flow but rectifier–2 is non-conducting. In the second half, consequent to a reversal of the voltage polarity, the rectifiers interchange their roles—1 stops conduction and 2 starts conducting. The result is a pulsating unidirectional current—a mixture of D.C. with fluctuating component—in the direc-

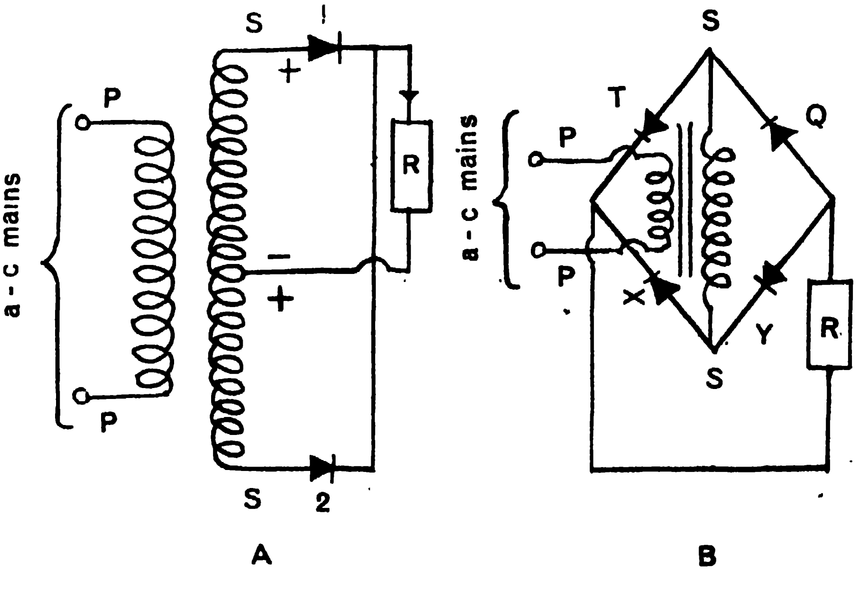

Fig. 5

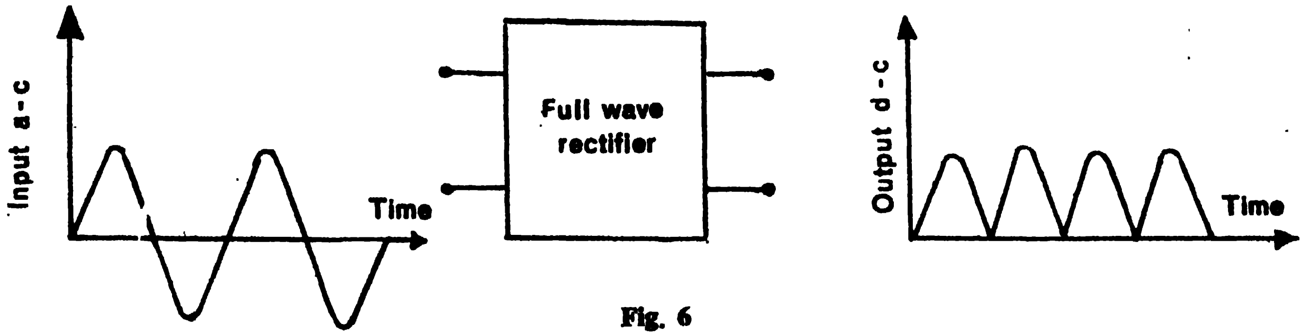

Fig. 6

tion shown, through the load resistance *R*.

In the full-wave bridge rectifier—so-called because the rectifier elements here are placed in a network like resistors in the arms of a Wheatstone bridge—current follows the path STRYS' in one half-period and the path S'XRQS in the subsequent half. Pulses of direct current are thus obtained.

In both cases, the waveforms of alternating current in the input and direct current in the output look like the chart in Fig. 6.

It is interesting to note that the centre-tapped transformer circuit gives a voltage output one-half the bridge circuit when energy from the same alternating-current supply is derived and the same transformer is used. This occurs because the centre-tapped transformer circuit makes use of (in each cycle) voltage across only half of the secondary coil.

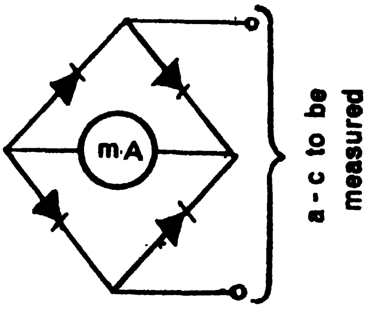

Fig. 7

Advantages and applications

The chief merit of the metal rectifiers is that, unlike the conventional vacuum diodes where cathode heating is indispensable, the metal rectifiers require no heating power. Moreover, in distinction to vacuum diodes, they can work in air so that an evacuated envelope is not necessary. The metal rectifiers have also an edge over the electrolytic rectifiers from the viewpoint of compactness. Other noteworthy advantages are installation without much difficulty and maintenance economy.

Often the circuit designer is confronted with a problem where a metal rectifier is the answer. The metal rectifiers, chiefly the copper oxide rectifier, is commonly used as a battery eliminator. The metal rectifiers may be designed to yield extraordinarily high current outputs at relatively low differences of potential and conversely incredibly low current outputs at comparatively large voltages. Such currents find use in specific technical applications, the former, for example, in industrial electrochemistry and the latter in X-ray work.

While in power applications, thermionic valves steal the limelight, the metal rectifiers (and the crystal rectifiers) are used in a number of electrical instruments. Important applications of the metal rectifiers are the rectifier A.C. meters—ammeters and voltmeters for A.C. measurements, designed on the principle that a sinusoidal alternating current of amplitude I_0 yields on conversion into direct current, a current of average value 0.637 I_0. Such an ammeter (Fig. 7) usually employs the bridge arrangement for full-wave rectification with copper oxide elements in the four arms and a D.C. Calibrations are milliammeter inserted diagonally, marked in root mean square values so that the ratio, root mean square value/average value equals 1.11. The rectifier voltmeter employs practically the same arrangement; a series resistance of a large magnitude is incorporated as usual.

Observations with these instruments may be vitiated due to several factors. First come the temperature effects on the rectifier itself. Secondly, these devices have resistance high enough to occasion an appreciable drop of potential difference. Thirdly, the signal fed may contain harmonic components so that a necessary presupposition is invalidated.

On the other hand, the rectifier A.C. meters extend to A.C. the advantages associated with D.C. moving coil instruments. In line with the common practice with moving coil devices, the range of A.C. rectifier instruments can also be enlarged. The difficulty arising from the non-linearity of the rectifier's volt-ampere characteristic is easily overcome.

An arrangement of the above type is employed for A.C. measurements in (Avometer A—amperes, V—

volts, O—ohms), also called Multimeter—a handy and self-contained multirange instrument widely used for recording A.C. and D.C. amperages and voltages as well as for determining resistances, such determinations being invaluable for detection of errors in circuitry.

Among the principal shortcomings of the metal rectifiers may be mentioned a low peak-inverse-potential ranging which in many cases necessitates a series combination of several rectifier units. Another drawback is that these rectifiers, in course of their function, quite undesirably squander away an excessive amount of energy in the form of heat. This heat is manifested as a temperature rise.

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How smoke precipitates

WHEN a solute like sugar completely dissolves in a solvent like water, solute crystals are distributed at random throughout the water. This type of solution is called a true solution because the particles of solute are individual molecules that will not settle out of solution on standing. When sand is mixed with water, the particles of sand do not dissolve but settle down at the bottom of the container. This condition is called suspension. Sometimes aggregates of molecules of substances exist in colloidal state—an intermediate between a true solution and suspension in which the solute particle size is also usually an intermediate between particle size in solution and suspension. Hence it is the particle size which distinguishes the colloids.

	Particle Size
Suspensions	10^8 Å to 10^3 Å
Colloids	10^3 Å to 10^1 Å
Solutions	10^1 Å to 10^0 Å and still lesser in size

A colloidal system consists of colloidal particles, called the dispersed phase, which exist in the medium called dispersing phase. Colloidal system can be prepared in which either the dispersed phase or the dispersing phase is solid, liquid or gas. Accordingly, there are eight types of colloidal systems (Table 1).

Smoke is essentially a colloid in which solid particles are dispersed in air. The particles may be carbon, siliceous matter, particles of metals, oxides of metals and other kinds of matter associated with industries. Each particle of the dispersed phase in a colloidal system carries an electrical charge. The charges come from the selective adsorption of ions from the solution. Since, like charges repel each other, the colloidal particles in a given system will tend to distribute themselves uniformly throughout the dispersing phase a reason why colloidal particles do not settle out upon standing.

Efforts to solve the problem of removal of suspended particles in air were made as early as 1824 by Hohlfeld, a teacher at Leipzig, Germany. He observed that if he electrified a wire in a bottle filled with smoke, the smoke cleared rapidly and a deposit formed inside the bottle. In 1884 Sir Oliver Lodge in England rediscovered the phenomenon. A commercially unsuccessful attempt was made to utilize this effort in 1885.

If an electrically charged particle such as colloidal particle is placed in an electric field between two electrodes, it will tend to move towards the negative pole if charged positively and towards the positive pole if charged negatively. Charged particles in an electric field tend to migrate towards the weakest part of the field. If one electrode is a metal pipe and the other is a wire suspended axially in the pipe and potential is applied to both the electrodes, the field around the wire will be intense and the intensity will diminish radially towards the pipe. The colloidal particles when placed in such a situation are propelled rapidly through the gases by force of the electric field from strongest to the weakest part of the field,

Table 1. Types of colloidal system

Dispersed phase	*Dispersing phase*	*Example*
Gas	Liquid	Foams
Gas	Solid	Pumice stone
Liquid	Gas	Mist, fog, cloud
Liquid	Liquid	Emulsions (Milk)
Liquid	Solid	Gel or Jelly
Solid	Gas	Aerosol, smoke
Solid	Liquid	Paints
Solid	Solid	Coloured Gems and glasses

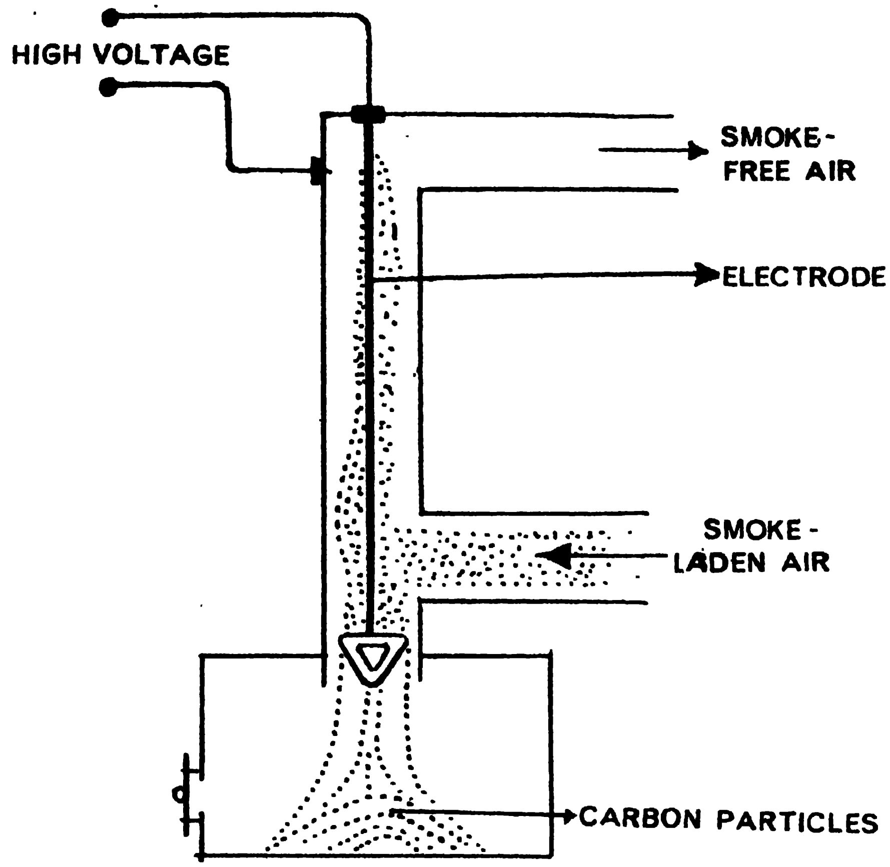

Fig 1. Cottrell smoke precipitator

from wire to the pipe surrounding it. This principle is utilized in Cottrell Electrostatic Precipitator which consists essentially of alternately charged high voltage plates through which the smoke passes before being let into the atmosphere. The dust particles, as they pass between the charged plates, acquire a static charge and are drawn to the oppositely charged plates where they are deposited. The cleaned gases pass to the upper header and out of the precipitator through a suitable flue (Fig. 1). The Cottrell Electrostatic Precipitator is valuable from economic point of view, because in addition to ridding the atmospheric pollution, valuable metals that would otherwise pass into air are collected as deposits on the plates. Recoveries of such metals have more than paid the cost of installation and upkeep in many industries in America and other countries. Other precipitators are also in operation using various types of electrodes and other devices.

In college laboratories of Shreeram Vidya Peeth, Shreeramnagar (A.P.), we tried to demonstrate the principle of Cottrell Precipitator through a simple device. This can be constructed easily in any high school science laboratory and demonstrated to students. It consists of a glass cylinder of 25.39 cm diameter and 91.43 cm height on which is wound a 24 gauge copper wire without gaps upto more than half of the cylinder. A thick copper wire of 2 mm diameter is suspended axially in the glass cylinder. The copper wire wound on the cylinder and the thick wire suspended act as the two electrodes (Fig. 2). As air is a poor conductor of electricity, an extremely high potential is to be applied. Under ordinary circumstances thousands of volts are required to breakdown the resistance. Hence the two terminals of electrodes are connected to an induction coil. Smoke by burning camphor or paper burnt in a separate container is allowed to pass into the chamber and the induction coil is switched on. Potential is applied to the electrodes and smoke is precipitated and deposited on the inner surface of the glass cylinder and clear fumes escape through a hole provided. It is also observed that as the potential applied increases, the precipitation is rapid and is achieved fully. This is

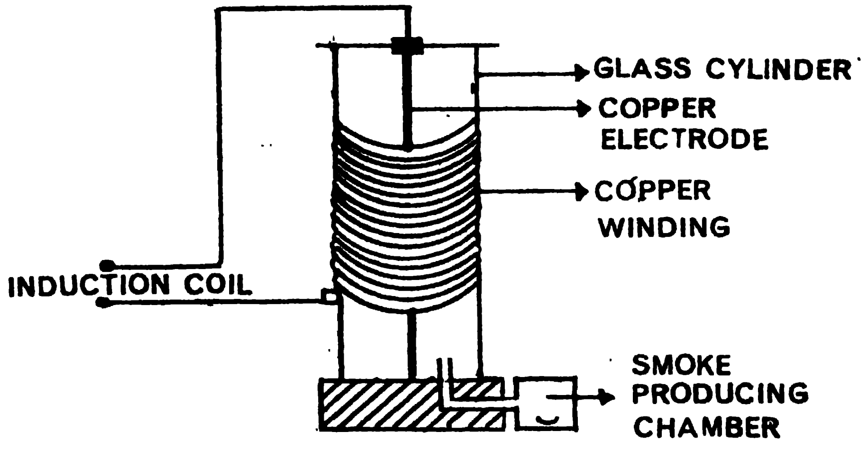

Fig 2. Smoke precipitator—Lab. model

a good demonstration of the principle involved in Cottrell's Electrostatic Precipitator.

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Repair of DNA in living systems

LIVING organisms are subjected to a variety of physical and chemical assaults from the environment. Some of them are natural like the UV rays from the sun, while others are several kinds of pollution caused by man. Exposure to hazards of these agents frequently damages DNA—the genetic material, which is so necessary for survival and perpetuation of living organisms. It is well-known that even a single base change in this giant DNA molecule can be lethal to the organism, yet the way these frequent damages are counter-balanced is really a remarkable feature of the living systems.

The living systems possess error correcting mechanisms to repair defects in their DNA and ensure genetic stability. These error correcting mechanisms are, however, not totally perfect. They have allowed some mutations essential for biological evolution to occur. Too much efficient repair systems might reduce the mutation frequency to such a low level that the species could become trapped in an evolutionary dead line. On the other hand, repair systems would obviously be advantageous in enabling species to maintain their genetic stability in an environment that caused mutations at a high rate.

Quality control

The genetic information is encoded in the sequence of molecular subunits called bases that are joined together along a backbone of phosphate and sugar groups to form the chain-like molecules of DNA. There are four bases in the DNA—namely, adenine, thymine, cytosine and guanine. Before a cell can divide and give rise to daughter cells, the DNA in the parent cell must be duplicated so that each daughter cell can be supplied with a complete set of genes. A single base alteration can result in a character different from the original one as in the case of sickle cell anaemia where a single base change in the triplet genetic code causes the incorporation of the amino acid valine in place of glutamic acid in one portion of haemoglobin molecule of red blood cells, thereby causing sickling of the R.B.C. in the affected individual due to low O_2 tension. It has been estimated that in bacteria the genes may be duplicated as many as 100 million times before there is 50% chance that even one gene will be altered. This is a remarkable record for any process and it is possible that such an accuracy is achieved only with the help of an error correcting mechanism. There is therefore a 'Quality control function' which works to preserve the structural integrity of this giant molecule.

Recognition of damage

The molecular architecture of DNA reveals certain features which facilitate both the recognition of damage as well its repair. The genetic material of all cells consists of two complementary strands of DNA linked by hydrogen bonds to form a double helix. The sequence of bases that constitute the code letters of cell's genetic message is supplied in redundant form (i.e., there are more genes for a particular function than are actually expressed at a particular stage), e.g., in *Xenophus* it has been reported that there are about 1600 ribosomal DNA (r-DNA) cistrons in a diploid cell, of which only 150 r-DNA cistrons are called for activity of the normal maintenance of a cell. Redundancy is a familiar stratagem to designers of error, detecting and error-correcting codes. The damaged portion of one of the strands of a DNA double helix can undergo repair by using the information in the complementary strand. The undamaged strand serves as a template for the reconstruction of damaged segment in the complemenatry strand.

Repair on exposure to light (Photoreactivation)

The repair system operates in different ways in different organisms. Actinomycetes subjected to a heavy dose of UV radiation, when subsequently exposed to an intense source of visible light, survived. Albert Kelner (1948, U.S.A.) explained the mode of UV action and the subsequent repair of damage in the following way.

The irradiation with UV resulted in the formation of two unwanted chemical bonds between pyrimidine bases adjacent to each other on one strand of the DNA molecule. Of

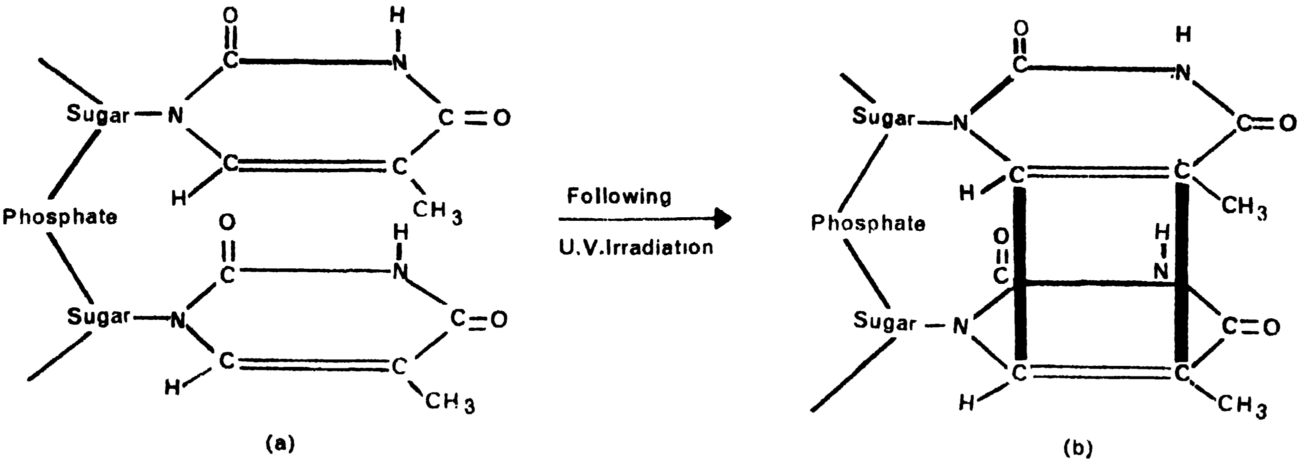

Fig 1. (a) Two thymine bases present adjacent to each other, (b) Dimer formation between adjacent thymine bases after irradiation with UV light

the three possible types of pyrimidine dimers, dimer formation between adjacent thymine bases is most common (Fig. 1). Richard B. Setlow (U.S.A.) and coworkers showed that the dimers block normal replication of DNA and bacteria with even a few such defects fail to divide. Claud S. Rupert (U.S.A.) and coworkers explained that exposure to visible light results in the activation of an enzyme which selectively binds to DNA irradiated with UV and facilitates the cleavage of pyrimidine dimers to restore the original DNA configuration. This process is called photoreactivation.

Repair without light (dark reactivation)

Yet another repair system which facilitates repair of damage to DNA is dark reactivation, so called because light has no role to play in the repair process. E. Witkin (1946) isolated a strain of the bacteria, *Escherichia coli* (B/r strain), which is particularly resistant to radiation. There are certain strains which however are sensitive to radiation (Bs-1 strain). It has been suggested that the radiation-sensitive bacteria lack one or more enzymes needed for repair of radiation-damaged DNA. It is probable that dark

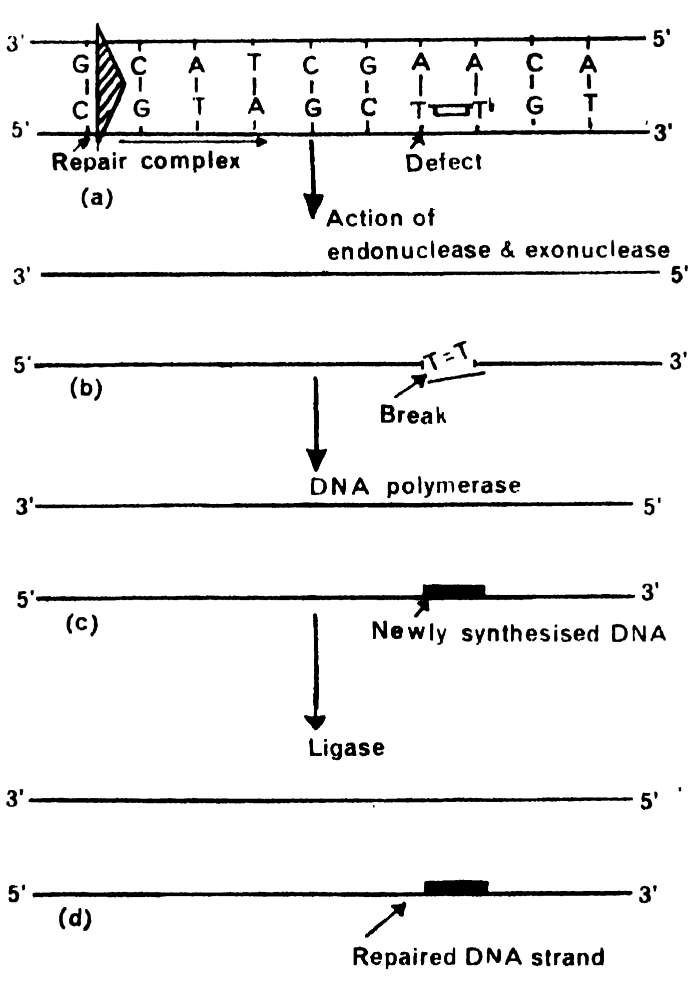

Fig. 2. The four possible stages of DNA repair demaged by UV tradiation, (a) & (b) Excision of dimer by sequential action of the repair complex, (c) Insertion of new complementary bases in the presence of DNA polymerase, (b) Final joining effected by polynucleotide ligase

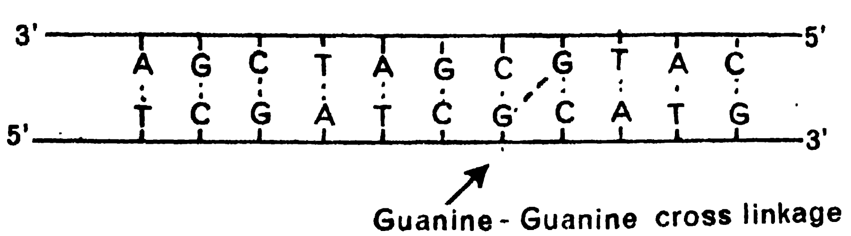

Fig 3. A guanine-guanine cross-linkage in the DNA helix which probably distorts the symmetory of its helical structure

reactivation takes place in the following way : (fig 2).

(1) In the first step, an endonuclease recognizes the local distortion so as to introduce a nick on the 5 side of dimer.

(2) A second enzyme excises a short stretch of the DNA strand including the dimer.

(3) DNA polymerase uses the intact complementary strand as template to synthesize a piece of DNA to fill the gap.

(4) The repair is completed by ligase action.

It has been suggested that in resistant cells sometimes the dimers are bypassed during replication of DNA so that they remain permanently present without causing any hazard in the normal replication.

Postulated models of DNA repair

It has been shown that DNA repaired by dimer excision and strand reconstruction could replicate in the normal semi-conservative fashion. This lends support to the idea that biologically functional DNA results from repair replication and that repair systems are an integral part of the normal cellular functions. Despite the diversity in the mode of repair in different systems, the detailed sequence of events that must be involved in this type of repair is visualized in the form of two models postulated quite a number of years ago.

The cut and patch model first proposed by Richard Setlow (U.S.A.) and others to explain how bacterial cells might remove thymine dimers. It postulates that an enzyme excises a short, single strand segment of the damaged DNA and new bases are inserted according to the rules of base pairing.

The patch and cut model. This was proposed as an alternative to the cut and patch scheme. It is assumed that a single incission cuts the defective portion of the DNA strand as the new bases are inserted. This model took form during a discussion at a conference on DNA repair mechanism held in Chicago.

Repair replication is not confined to bacterial systems like *Escherichia coli* alone, but is of general biological significance as the process is widespread in more complex cellular systems belonging to Eukaryotes. Cells of *Tetrahymena pyriformis* and several mammalian cell lines in culture as well as the Hela cells (human cell lines in culture) perform repair replication.

Agents which injure the DNA

Apart from UV irradiation, alkylating agents have been shown to be involved in repair replication of DNA in *Escherichia coli.* There are also evidences which tend to indicate that defects produced by X-rays, nitrosoguanide and the antibiotic mitomycin-C can also be repaired in radiation resistant strains of *E. coli.* The biological action of alkylating agents is a complex one. They are known to react with the purine bases, particularly guanines at the N-7 atom, and the bifunctional agents (*i.e.*, those with 2 reactive alkyl groups) may bring about cross-linking between guanine bases present on the opposite strands in the DNA molecule. (Fig. 3). Alkylation of purines in position 7 may also give rise to unstable quanternary nitrogens so that the alkylated purines may separatefro m the deoxyribose leaving a gap which might interfere with DNA replication. The lethal action of ionising radiation or alkylating drugs is thought to involve the formation of electrophilic species (many of which are free radicals in nature) which interact with essential molecules as nucleic acid. The protective effect of certain nucleophilic compounds like cysteamine has been attributed to its ability to scavenge these species to prevent their reaction or to reduce chemically the free radical lesion thereby resulting in its repair (R.L. Wilson and others, 1974, U.K.).

Pathological conditions

Repair replication of DNA has been found to be defective in certain pathological conditions. The mechanism of repair synthesis is defective in the skin fibroblasts of patients suffering from the condition known as *Xeroderma pigmentosum* (Akiba, H. ; Kato, T. and others, Japan, 1975).

Poon, O'Brien & Parker (1974) have presented a very interesting case in their studies on DNA repair by fibroblasts from a patient with Fanconi's anaemia. Fibroblasts from such patients were found to be defective in the excision of DNA lesions. This probably is the result of a deficiency in an exonuclease function which removes the damaged strand of DNA after the endolytic scission has been made.

It is evident that DNA molecule not only contains a series of blueprints but also a coordinated programme of controlling its execution.

It is therefore dynamic in terms of its functions as it strives hard to preserve its unique qualities and maintain its structural integrity in the face of an allround attack by various environmental agents. The repair replication is a versatile process and investigations directed to reveal the structure and organisation of various enzymes, and a range of DNA defects that can be recognized and repaired may prove to be of immense significance in biology and medicine.

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Plankton in fresh waters

PLANKTON is a collective term coined by Hensen (1887) for the minute floating life in all types of aquatic systems such as pools, ponds, lakes, rivers, etc. It includes both plant and animal communities, and is referred to as phytoplankton and zooplankton respectively. Generally the planktonic organisms are found floating at the surface layers of water. However, they slowly descend vertically to the lower levels of water and then ascend to surface again. These two-way vertical movements are known as 'diurnal migrations' of plankton.

Limnology is the study of fresh water ecosystem. Plankton study is an important aspect of limnology. The abundance of plankton in an aquatic system is an index of high biological productivity (i.e., the rate of photosynthesis in which solar energy is utilised to convert CO_2, H_2O and nitrogen compounds into energy locked carbohydrates, proteins and fats). Plankton being a productive base provides food to the higher aquatic animals like fish and indirectly to man.

Phytoplankton

Diatoms and other algae are the main constituents of phytoplankton. Diatoms are invariably single-celled. Yellow green algae with silicon shell have various shapes. There are two halves in the shell, and they are closely fitted together like the top and bottom of a capsule. The green algae such as *spirogyra*, *oscillatoria*, *nostoc* and *anabaena* have long filaments. Unicellular protists like *euglena*, *chlamydomonas*, *chlorella*, *volvox* and *pediastrum* are very common among the phytoplankton. Usually the algae form green scum over the surface of calm, stagnant waters. The chlorophyll present in the cells of diatoms and algae serves for photosynthesis. Phytoplankton capture and store solar energy and form good source of food to the animals.

The growth and distribution of the phytoplankton depend upon certain physical, chemical and biological factors. When the atmospheric temperature increases, the water gets heated slowly. Consequently the dissolved O_2 is depleted

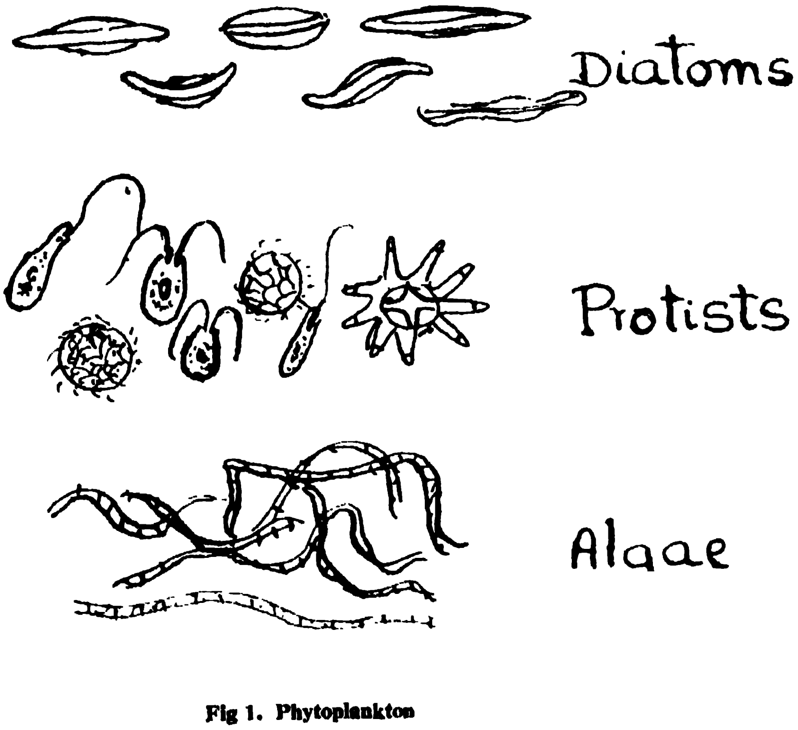

Fig 1. Phytoplankton

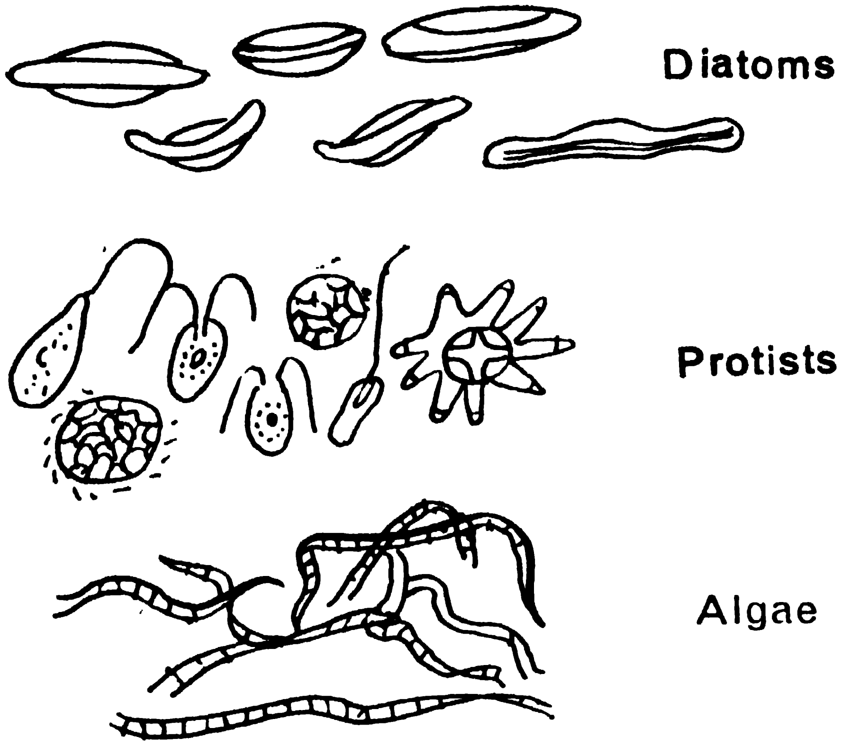

Fig 2. Zooplankton

from the epilimnion (upper layers of water in a pond or lake). The absence of oxygen inhibits their growth and even leads to their sudden disappearance due to death and decomposition. The extent of organic decomposition, pH value, available nutrient minerals and the occurence of herbivore animals in that locality are other deciding factors in this respect.

Phytoplankton can be cultured very easily in the inland waters. If natural manures like dung and domestic refuse are added to the water in a pond, phytoplankton blooms can be observed in due course of time. Urea, superphosphate and other chemical fertilisers may also be used carefully according to the need.

Zooplankton

Eggs and larval forms of higher animals, copepods, cladocerans and rotifers are common among the freshwater zooplankton. The eggs and larvae are only temporary plankton. Crustacean larvae such as nauplius, zoaea and mysis are observed in certain seasons only. Calanoid and cyclopoid, copepods have long dorsoventrally compressed body. They resemble the common prawns in their shape, though very minute in size. Cladocerans have an oval body covered by bivalved carapace. Serrated caudal spine and a beak-like projection at the mouth region are present in species like daphnia. Rotifers are notorious in having a silicate spiny shell or 'lorica' covering their body, and a rotating ciliary mechanism surrounding the mouth, e.g., in bachionus, keretella and hexarthra

Food chains

Crustacean larval forms, copepods, daphinids etc. feed on phytoplankton and are known as herbivores or "primary consumers". Rotifers feed on small unicellular organisms. All these animals, in turn, are eaten by other animals—the "secondary consumers". Fishes and other higher animals are the consumers of the third order, however some of them are herbivores or the secondary consumers.

Diurnal migrations

This is a peculiar phenomenon exhibited by plankton. During day time the phytoplankton carry on photosynthesis and prepare food. But zooplankton that cannot tolerate light intensity remain at the lower levels of water where the effect of light is less. After sunset the planktonic animals begin to migrate vertically upwards and slowly reach the surface layers. They graze upon the phytoplankton or on primary consumers that assemble there. All these planktonic animals remain at the surface layers throughout the night, and also upto early hours of the next day. But at dawn they once again begin to sink down to the lower levels. This is a very common type of diurnal migration of the plankton There are however, many deviations from the common type.

Diurnal migration of plankton is usually known as "photoperiodism" as it is effected by light. Other physical factors such as temperature, water currents, etc. and the consequent hydrological and biological factors also affect them. These migrations are so rhythemic and seasonal that we can presume the level of occurrence of the plankton in lake waters by simply seeing the clock and calendar.

The obvious cause of the diurnal migration of plankton is the presence of food at the surface waters. Even if the food is made available at lower levels, or removed from the surface levels of water, the plankton begin to ascend up after sunset. Therefore, there may be some other inherent driving force in them which causes diurnal migrations.

Plankton and fisheries

The study of plankton and its diurnal migration helps explore and exploit the fresh water ecosystem. Carp fishes such as Catla, Labeo, Cirhinus, etc., prefer to live in the standing fresh waters and feed on the plankton. Fishes are extensively being cultured in the surroundings of Vijayawada and Kolleru in Andhra Pradesh. Carp fishes normally breed in the running waters. However, a new technique known as "induced breeding" has come to light recently. The adult fishes are given pituitary njections. Within days groups of fry appear. Feeding on the plankton they grow quickly. Tonnes of fishes can be harvested in an acre of land annually, provided the dangers of infection, overpopulation, and the predators are overcome. For an efficient management of a fish farm the knowledge of plankton and its culture is quite essential. The rate of fish catch in lakes and riverine reservoirs can be increased by studying the diurnal migration of the plankton in them.

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The nema tails

THE article **A tale of tails** by Drs. K. K. Tandon and Pushpinder Kaur (*S.R.*, Dec. 1976) makes interesting reading. While it is true that the tail is typically absent in a majority of the invertebrate groups, it is very much present in one group, the Nematoda.

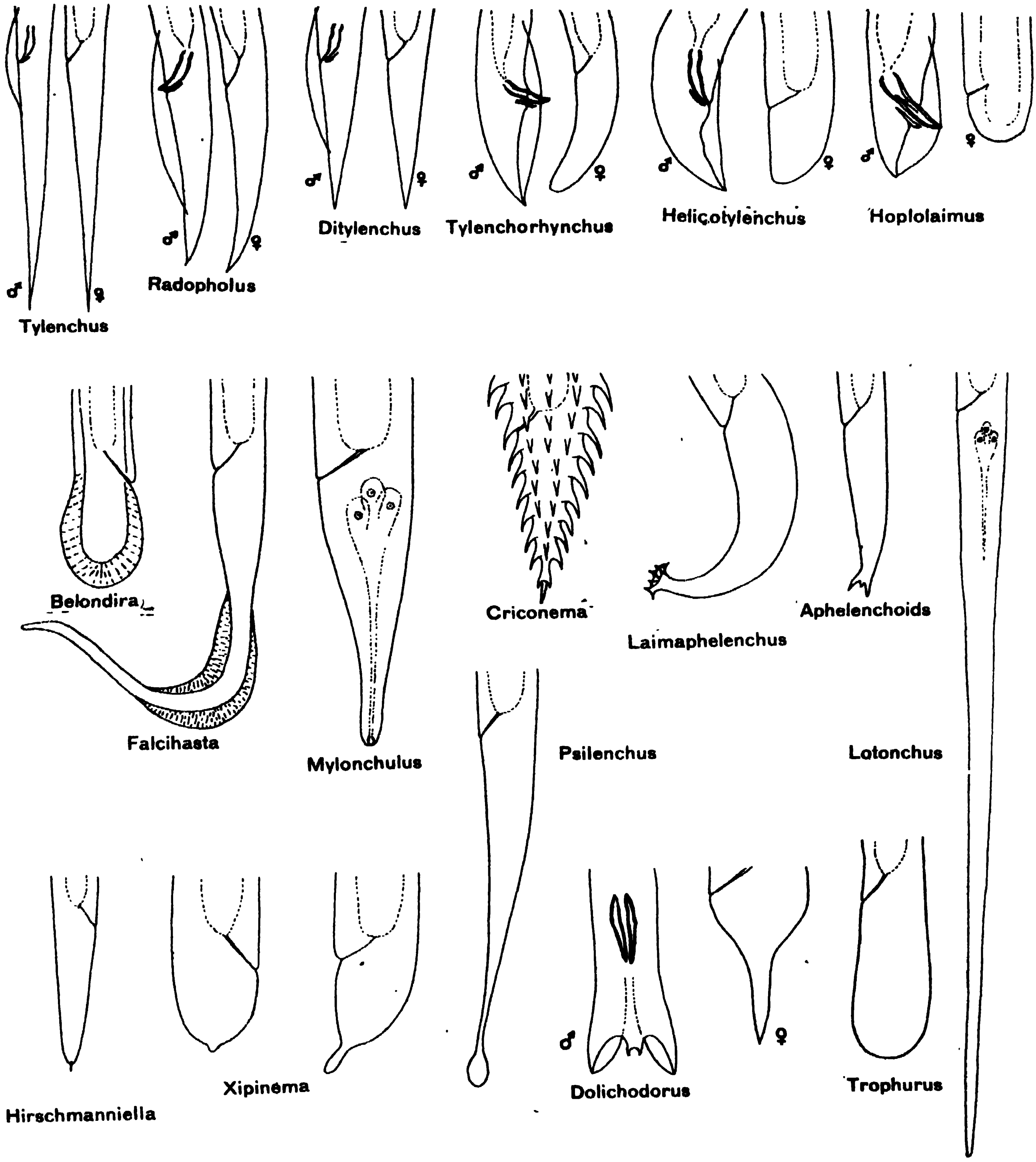
There exists some controversy as to what exactly a tail is. While some authors mention it to be the posterior extremity of an animal—usually a slender prolongation beyond the anus—others define it simply as a free posterior elongation of the body. If we consider the former definition, which embryologically appears more appropriate, nematodes are the only invertebrate animals which possess a true tail in the adult as well as in juvenile stages. However, considering the tail in a more generalized way as expressed in the latter view, the larval stages of Platyhelminthes, especially of trematodes (e.g., cercariae), can also come under this category. The cercariae possess some remarkable modifications of the hinder part of their body which is purely an adaptation for swimming. This part of the body which is referred to as 'tail' is lost when the animal attains maturity.

The tail in nematodes is of different types, which are far more numerous than all the vertebrate tail types. Whether such structural diversity is also correlated with functional differences is yet to be ascertained. Nevertheless, from an academic point of view, it is of immense importance. The nematodes are a diversified group of animals occupying all the possible types of habitat (marine, fresh-water, soil-inhabiting and parasites of plants, invertebrate and vertebrate animals). Some interesting types of tails that occur in nematodes, more particularly in the plant and soil-inhabiting forms, are given in Fig. 1.

Unlike vertebrate tails, the post-anal part of the body which forms the tail in nematodes is devoid of any skeletal support, as these animals are provided with neither an exoskeleton nor an endoskeleton. The tails, whether useful to the animal or not, are certainly very useful to the nematologists (scientists who study nematodes) as they provide good characters for quick identification. Quite often, the tails of the two sexes of a species are different and so help in distinguishing a male from a female. The male nematodes are usually provided with wing-like expansions of the cuticle known as caudal alae or bursa. The latter holds the female during copulation. Variations in the size, shape and extent of bursa provide further variety to the tail. In a few species, the hinder part of the gut extends into the tail forming a post-rectal blind sac which is certainly a unique feature unknown in any other group of animals whether vertebrate or invertebrate.

Certain primitive nematodes are provided with large (caudal) glands in the tail. These glands have ducts which open at the tip through an aperture (spinneret). An adhesive substance is secreted by these glands which helps in anchoring the animal to the substratum. Such a modification is of great utility to those nematodes which live in running waters, for they can keep anchored at any desired spot while surveying the area around them without the least danger of being swept away. When the animal wishes to move away from this spot, the adhesive is dissolved and the nematode gets detached.

The size and shape of the tail varies in all the species of nematodes, but still it conforms to some broad types. In general, it shows a tendency of regression from the very long and filiform (e.g., *Tylenchus*) to a short and hemispheroidal tail (e.g., *Hoplolaimus*). Between these



Tail types in nematodes

two extreme types are found numerous intermediate types. Some of the significant ones are the elongate tails of *Radopholus*, elongate-conoid tails of *Ditylenchus*, conoid of *Tylenchorhynchus* and the bluntly rounded tails of *Helicotylenchus*. The males which possess a long tail incidentally have a small bursa restricted only to the anal region. However, with the gradual decrease in the length of tail, the extent of bursa increases which indicates that the bursa size is indirectly proportional to the tail length. In *Radopholus* and *Ditylen-*

chus males, more than half the tail is covered with bursa, while in *Tylenchorhynchus*, *Hoplolaimus*, etc., the tail is completely enveloped by these wing-like expansions.

Other interesting variations may be seen in *Hirschmanniella* and a few species of *Helicotylenchus* which are provided with one or rarely two spines (mucro) at their tail tips or *Aphelenchoides* and *Laimaphelenchus* which have cuticular ornamentations of different types. Digitate and mammalate tails are found in many species of *Xiphinema*. *Criconema* species have tails that are provided with sharp spines or blunt scales. Large and well developed caudal glands are present in *Mylonchulus*, while *Iotonchus* may have an exceptionally long whip-like tail. A very peculiar feature is present in *Falcihasta* which has fin-like expansions along the middle of the tail, but in species of *Belondira* the entire tail may be expanded and fin-like. The tail of *Psilenchus* is filiform but its terminus is peculiarly swollen, club-shaped; whereas the tail of *Trophurus* is short but entirely clubbed. The males of *Dolichodorus* have characteristic tri-lobed terminal bursa while their females have a short rounded tail which abruptly tapers to a sharp point.

The tail is evidently a locomotory organ and an aid in swimming especially in the marine and freshwater nematodes. However, the fact that it has persisted and remained equally pronounced in the majority of soil-inhabiting and parasitic species is amazing. Perhaps it represents a trait reminiscent of its aquatic ancestors. A closer study of the parasitic and non-parasitic forms reveals that with the gradual restriction (parasitism) in movement of the animal, the tail becomes progressively reduced. This fact is exemplified by some endo and semi-endoparasitic nematodes such as *Heterodera* and *Meloidogyne* in which the adult females lack a tail while the juveniles and the non-parasitic males have one. In some nematodes like *Xiphinema* the larval stages may possess tails longer than those of the adults although both are ectoparasites on the plant roots. Some recent observations have revealed that during the process of egg-laying the flexing of tail sharply increases which indicates that it may be aiding the process. The male during the process of copulation coils the tail tightly around the body of female and uses it in maintaining the correct posture during the act.

It can be concluded that diversity of tail types in nematodes certainly surpasses that of the entire vertebrate groups.

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Mass stranding of whales

STRANDING of whales attracts public attention. It is because, save the minor members of the whale family such as the porpoises and the dolphins, whales are rarely seen in the coastal waters. Stranding of whales enmass often causes panic among the fishermen. They interpret such phenomena as the wrath of sea gods and try to propitiate the angry gods by offering worship to the stranded ones.

Stranding of schools of whales has been reported from maritime countries like the U.S.A., U.K. and Australia. Such incidents are also on record from Indian coasts The recent one was beaching of more than 100 pilot whales off Manapadu on the east coast. The tendency to strand in shallow waters is prevalent among toothed whales. This tragedy is known to strike killer whales, false killer whales, pilot whales and even the giant sperm whales.

The peculiar nature of toothed whales to strand in shallow waters suggests some imperfection in their direction-finding mechanism. Whales use sounds in their navigation. The toothed ones produce high pitched clicks to locate preys as well as to stay clear of obstacles in their path. They are unable to find proper direction when their clicks are not reflected back. The gentle slope of the ocean floor or its muddy nature is sometimes responsible for the tragedy. The clicks are not reflected back by a muddy floor as the former are absorbed by the latter. Generally the great Baleens are free from the malady. They produce low pitched sounds which bend over the obstacles. They can sense the danger from a distance. Isolated strandings of Baleens may be either due to sickness or mortal injuries received from the propellers of passing ships or from predators like the killer whales.

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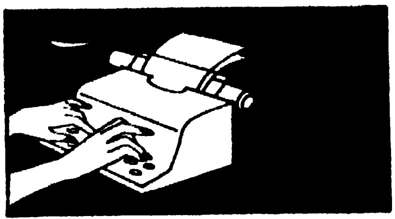

NEWS & NOTES

Prof. K. L. Chopra —Bhatnagar Award Winner

WHAT is the key to your success? One cannot resist the temptation of putting this question to a successful man, particularly to the one who is the recipient of the country's most prestigious scientific research award, the S. S. Bhatnagar Memorial Award of the C.S.I.R. The successful person in question in this interview is Prof. K. L. Chopra, of Department of Physics, I.I.T., New Delhi who shared the 1975 Physical Sciences Award with Dr. B. R. Nag, for his researches in Solid State Physics.

For the key to success, Prof. Chopra looks back to his days spent at the University of British Columbia, Canada. "The very first day I arrived at the University as a World University Service Fellow," mused he, "I expressed a desire to my supervisor that I would like to learn the workshop practice. Looking at me well-dressed, he was taken aback. But on my insistence, he took me to the workshop and asked one of the M. Sc. students to train me on his own job of threading a long brass rod. The student was enthusiastic in getting help, and he let me sweat on the job while he enjoyed smoking cigarettes. From that day on, I was determined to learn to work with a variety of machine tools, lathes, glassblowing, and repairing of instruments. It gave me a great pleasure to emulate the research students around me who did all their work by themselves. This attitude has stood me in good stead in my life as an experimental physicist". Today, according to him, this very attitude has become the key philosophy of his research school at I.I.T., New Delhi.

Indeed, for experimental work, a researcher should be prepared to labour for anything. The lack of such attitude in the country, a disrespect for manual work that has been perpetrated in our minds and culture through the last many centuries, is what hinders progress in science and technology. Theoretical science is certainly a luxury to be enjoyed by the developed countries, but for an underdeveloped country like ours experimental science is the only panacea. Prof. Chopra is very correct when he adds that "poor quality of scientific work in India has only a small connection with the lack of facilities. Primarily, it is due to lack of a scientific and technological culture, proper attitude, dedication and commitment on the part of the scientists working as a group".

Born on July 31, 1933, at Chahal Kalan, West Punjab (now Pakistan), Prof. Chopra did his early education at D.A.V. Higher Secondary School, N. Delhi, B. Sc. (Hons.) and M.Sc. at the University of Delhi, and went abroad for Ph.D. Belonging to a family of farmers and teachers, Prof. Chopra says that he did not receive encouragement outside his family. "It is so because we, as a nation, do not subscribe to the concept of encouraging and honouring our own talents." He should know better because he has spent seventeen years abroad, in countries such as Canada, West Germany and the U.S.A.

Prof. K. L. Chopra

Since childhood, Prof. Chopra has marvelled at the wide variety of materials used by mankind. "I have often wondered how new materials could be created," he says, "and it is this curiosity which inspired me to take up research in Solid State Physics as a career". Today, he has received the Award for the outstanding contributions he has made to the understanding of the structure of thin films, the effect of electric fields on their growth and the effect of vacancies on electron transport. He also has developed novel techniques for growing thin films with special properties and useful applications, which are being adopted by the industry. Asked what he thinks about research as a career, he replied that "research in science should be undertaken by only those who have the commitment and devotion of a deeply religious man".

Anything to say about science popularisation? His reply is quite pertinent. Prof. Chopra said, "Science can be popularised in India only if we have scientists who love to do science writing, have devotion and commitment, without any consideration to financial gains". He added, however, that the financial gains should, of course, be made available without asking.

DILIP M. SALWI

First International Symposium on avian endocrinology

THE First International Symposium on Avian Endocrinology was held at Calcutta, during January 10-15, 1977. It was convened by Professor Asok Ghosh, Sir Nilratan Sircar Professor of Zoology of the University of Calcutta. The Symposium was presided over by Professor Donald S. Farner, the Chairman of the Department of Zoology, University of Washington, Seattle, U.S.A.

The first international seminar on specialized aspects of avian endocrinology was held in Japan in 1969, under the leadership of Professors Farner and Kobayashi. The focal theme of the Calcutta seminar, however, cen tredaround the problems related to hypothalamic control and the avian reproduction.

India is fortunate in having quite a large population of this fascinating and economically significant group of vertebrates. India posses-ses about 1,200 avian species representing 20 orders as against about 8,600 species and 27 orders in the world. This is definitely a very high number and represents a great variety for any single country. Further, the birds we see in India are a splendid cross-section of the total avifauna of the world. The holding of the 'First International Symposium on Avian Endocrinology' in India is appropriate.

The applied avian endocrinology deals with the process of reproduction in birds like other group of vertebrates. It is dependent on the hormonal secretion and an understanding of this relationship can provide information that may be usefully applied when, for economic reasons we may wish to increase or control, the fecundity of a species.

Both theoretical and applied aspects of avian endocrinology was discussed and the role of hormones on poultry and egg production was emphasized. A number of papers were presented on pest birds and birds which are agriculturally beneficial and there was a general opinion that a scientific inventory on this aspect would certainly help avian endocrinologists all over the world in the biological control of pest birds and an increase in the population of the beneficial birds.

Birds are to a large extent economically beneficial; they are also, of course, scientifically interesting and aesthetically delightful. Yet some species become pests when present in large number or in the wrong places.'

Avian endocrinology is the study of endocrine glands in diverse species of birds including poultry, game and wild. The prime academic objective of this subject is to reconstruct evolutionary pathways by the study of living avian species. Apart from contributing to the over all phyletic study, we also aspire to rebuild the lines of evolution within the endocrine system itself taking both morphological and functional criteria in our account. We can concern ourselves with the molecular evolution of hormones, with the probable acquisition of new active sites conveying new properties and finally explaining the mechanism of hormone action in terms of receptor protein and consequent genetic effects.

The academic aims just described are not, however, sufficient justification for the men with a more materialistic outlook. The applied avian endocrinology is the answer to them. Although there is a respectable endocrinology of the poultry birds (particularly the chicken and not so much on the duck), there has been rather restricted concern with potentially egg and meat producing wild birds. Regarding the birds of agricultural importance, we must attempt to prepare an inventory, to determine which birds do harm, which is beneficial, and which is of neutral status; so as to which species should be encouraged near the agriculture and which should be discouraged. In the near future, we hope a full fledged discipline of 'Economic ornithological endocrinology' will emerge and prove particularly significant to the developing countries.

After the great success of this seminar, some of us started thinking whether holding an international symposium is possible encompassing multiple aspects of the avian endocrinology. Just about two years ago from now I had the fortune of meeting in Calcutta three top-most avian endocrinologists like Professors Farner, Kobayashi and Assenmacher. They all enthusiastically agreed to the proposal and with their approval we approached other distinguished scientists of the field. Their response was also tremendous.

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MEDICAL NOTES

Dental caries-causation and prevention

THE human teeth, gums and the oral mucosa are affected by a number of diseases and disorders. The most common dental diseases in India are the dental caries and the periodontal disease or pyorrhoea. Dental caries has been affecting the human teeth since times immemorial (Fig. 1). Tooth decay which is a major oral disease begins at an early age. Although susceptibility to dental caries is not established to be related to socio-economic level of the community, yet it has been observed so. Dental caries in the primary dentition may occur as early as in the first year of life. The caries pattern of a child is related to the caries pattern of his parents, his brothers and his sisters. At any given age, girls show a higher caries attack rate than boys. This difference is probably due to the earlier eruption of teeth in girls. There is a mention about caries in the *Sushruta Samhita* under affections of the mouth (Mukha-roga), where it has been called as *Krimidantaka.*

It is primarily a disease of hard tissues of the teeth, i.e., of enamel, dentin and cementum (Fig. 2). There is no resemblance of this disease to caries of the bone (bone tuberculosis). It is a progressive destruction and disintegration of the tooth substance. To start with, it is a painless and an irreversible process. It is an unique pathologic entity because whatever damage is done to the tooth by it cannot be undone by the repair processes of the human body. It is neither infectious nor contagious nor a congenital malformation.

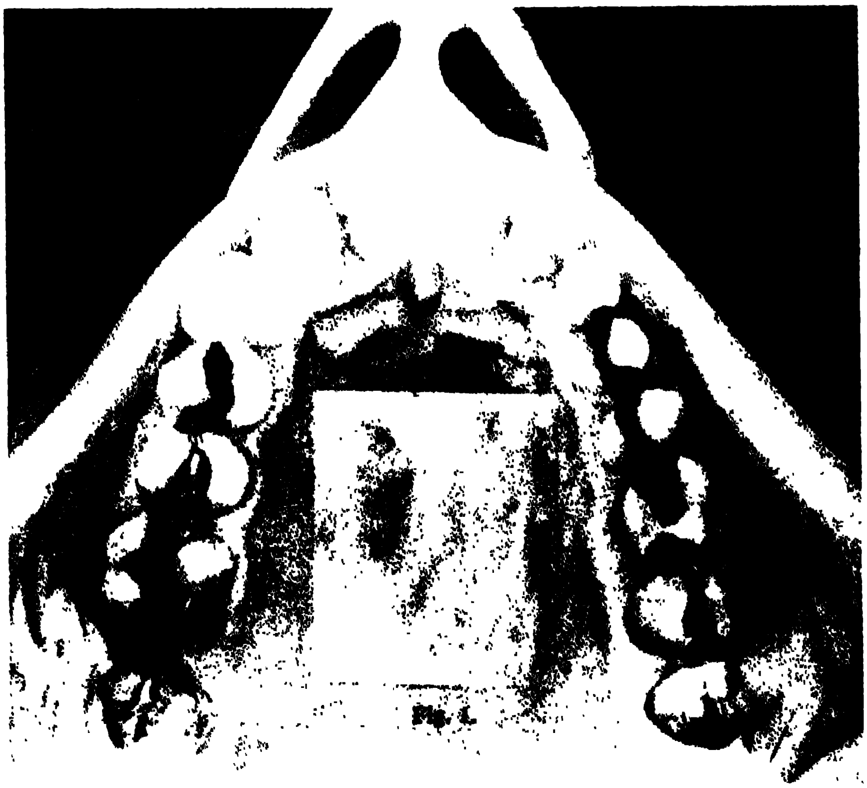

Fig. 1

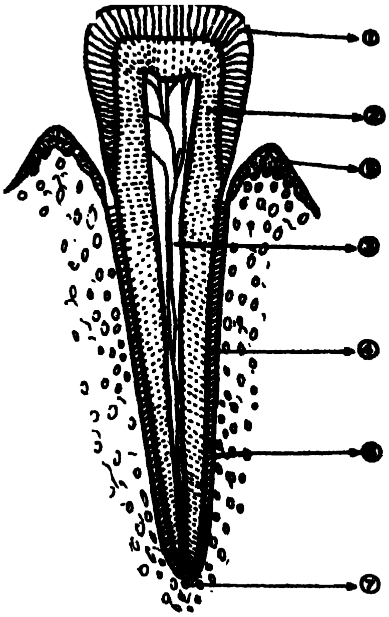

Fig. 2.

Incidence

It has been labelled as a disease of the Western countries but this is wrong. It is very much prevalent in our country. Different surveys conducted, in others as well as in this country, reveal that the incidence is on the increase not only in the developed countries but also in the developing countries. More and more children are affected by it. It is second important disease next to pyorrhoea for loss of teeth in Indians. G.F. Taylor and C.D. Marshal Day, Faculty of Dentistry, Punjab University, Lahore observed in 1939 a low incidence of caries in Kangra Valley in Punjab. C.D. Marshal Day and G.C. Tandon, Faculty of Dentistry, Punjab University, Lahore (1940), from another group of children in Punjab, recorded that caries was much less than in American children. K.L. Shourie, Nutrition Research Laboratories I.R.F.A., Coonoor (1941) made a comprehensive survey of children from various parts of India. He reported that 44.5% of children were free from caries which was considered to be much higher than that recorded in children in England and U.S.A. The incidence of caries in deciduous teeth was higher in girls than in boys. Urban children in all age groups showed more caries than the rural children. Thereafter, a number of surveys carried out by B.R. Vacher, Govt. Dental College & Hospital, Amritsar (1952), S.L. Mangi and V.P. Jalili, College of Dentistry, Indore (1961) showed the caries incidence to be on the increase.

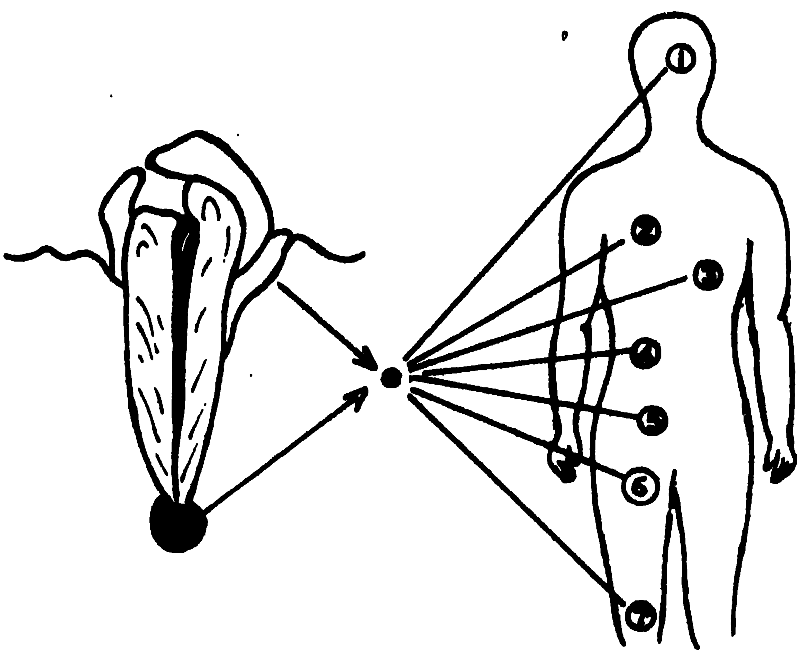

Fig. 3.

Pathogens

How it is caused ? Dental caries has a multifactorial etiology not only from the point of micro-organisms but also from the consideration of amount and type of carbohydrates used. The physical and chemical properties of saliva may influence dental caries susceptibility. There are three major factors in the pathogenesis of dental caries: (i) the fermentable carbohydrate foodstuff, (ii) the oral microbial enzymes, and (iii) the physical and chemical composition of the tooth surface. The first two may be considered as attack forces and the tooth surface as the resistance force. The oral cavity may be said to be a good incubator. There are millions of micro-organisms in the mouth. There are no means to make the oral cavity sterile of bacteria nor we wish to do so. Whatever food we eat is first incised and masticated by teeth and then swallowed. Micro-organisms and their enzymes help in the fermentation and degradation of the food. They help in the production of acids such as lactic, pyruvic, acetic, propionic and butyric. About 18 species of bacteria have been isolated from the mouth. They have been found to be actively associated with caries production and the most important of them is Lactobacillus *Acidophilus odontolyticus.* This particular micro-organism can live at a pH of 3.5. It is both acidogenic and aciduric, i.e., it produces acids and lives in an acidic medium. So cooked or boiled carbohydrates in our food are fermented and broken down into acids with the help of enzymes secreted by the micro-organisms. When the teeth are not cleaned regularly, the plaques of food are formed on the tooth surface. The acids accumulate under the plaque and come in contact with the tooth surface. When the pH of the acids reaches 5.5 or below, it causes demineralization of tooth substance, i.e., the inorganic salts are dissolved and the organic matter disintegrated or liquified to form a cavity. This theory is called chemico-parastic theory. There are other theories as well but not so widely accepted. Inspite of all the research on this subject, there is no single theory to explain all aspects of this disease. It may be important to know here that the enamel of the tooth is 96% inorganic salts and 4% organic matter and water. The mechanism of caries production in short, is as follows:

$$\text{Carbohydrates} \xrightarrow{\text{Enzymes}} \text{Acids} \xrightarrow[\text{5.5 or below}]{\text{pH}} \text{Demineralization} \xrightarrow{\text{Micro-organisms}} \text{Liquefaction} \longrightarrow \text{Caries}$$

Types

Caries of the teeth could be acute or rampant when the susceptibility is very high. Almost all surfaces of the teeth are affected. Even the very immune areas, viz, the cervical and proximal surfaces of mandibular incisors are involved. The other type is chronic or slow growing. It may involve one tooth or a group of teeth at the same time. There is another type called arrested, where further progress of caries does not take place because the area had become self-cleansable and the secondary dentin has formed.

Features

What are the signs and symptoms of caries. ? How can we detect it ? First of all, there is a loss of polish and translucency of the booth surface, i.e., it changes colour from white to dark or black. The area becomes soft and porous and the food starts getting lodged into it. The person becomes sensitive to cold and hot drinks and sweet and sour things. It gives mild to severe toothache depending upon the nearness and involvement of the pulp. The tooth becomes tender and one is not able to chew food with it. The dental specialist can diagnose it by clinical examination with the help of X-rays and other tests. In *Sushruta Samhita* the symptoms are described thus: "The teeth become loose and perforated by black holes accompanied by a copious flow of saliva. The appearance of an extremely diffused swelling (about the roots of decayed teeth) with a sudden aggravation of the accompanying pain without any apparent cause is also one of its specific features". Once the pulp is involved, it becomes a passage for the oral micro-organisms to travel into the bone. Swelling appears into that area and other complications of inflammation follow.

Treatment

There is no medicinal or radical cure for it. The key to good health is prevention, and that is true to this disease too. In *Sushruta Samhita* the following has been said: "A person suffering from any affection of the teeth should refrain from taking acid fruits, cold water, dry food, excessively hard articles of food and brushing teeth with a twig". There are two major methods of preventing dental caries. The first is by increasing the resistance of tooth enamel to external attack. The second is to reduce the intensity of the attacking agents, i.e., the fermentable carbohydrates and the microbial enzymes. The most important factor for promoting resistance of teeth to dental caries is the systemic and topical administration of fluorides. For reducing the intensity of the attacking agents consumption of sticky, sugary preparations should be restricted and a proper method of tooth cleansing should be adopted to reduce the accumulation of bacterial plaque on the surface of teeth. In short, the following are the treatment measures:

1. Avoid taking candies and readymade sugary items such as sweets, toffees, lollipops, chocolates, chicklets, biscuits, cakes and pasteries.
2. Use fibrous detergent food such as spinach, cabbage, salads, and finish the meal by an apple or a carrot.
3. Ideally, brush your teeth after each meal; if not, at least twice in twenty-four hours, once at night before going to bed and once in the morning after the breakfast. After dinner we are going to have a sleep for 6-8 hours. If we do not brush after dinner, the food particles which are left in the mouth will ferment and help in caries production. Similarly, our breakfast consists of more of soft, sticky food articles like bread, biscuits, etc., hence teeth should be brushed after breakfast. Also do a finger or a terry (cloth wrapped on a finger) massage. After lunch a thorough rinse will be good. One should not take anything in between the meals. Chewing betel leaf, nuts and suparis should be avoided.
4. Pregnant and lactating mothers should take nourishing food so that their newborns have strong and well formed teeth.
5. Use of fluoride in several ways helps reduce caries incidence. Fluoridation of community drinking water is an important means of doing so. Fluoride is added in the ratio of 1 part per million parts of water. This limit should not exceed.
6. Topical application of fluorides on the freshly erupted teeth in children may be done at intervals.
7. Dental pastes and powders containing fluorides should be used.
8. Fluoride tablets are used as a tonic for teeth and fluoride in milk powders is advocated when it is deficient in drinking water.
9. Use of sealants and prophylactic odontotomy is advisable to prevent initiation of caries.
10. Proper intake of calcium, vit. D and phosphorous during the development of teeth is desirable.
11. Mouth should be properly rehabilitated. There should be no ill-fitting dentures or restorations.

The curative treatment, however, consists of removal of carious tissue and restoring it by artificial means like cements, eugenol pastes, acrylic resins, alloys. gold inlays and crowns. In advanced cases pulpotomy is undertaken, i.e., the pulpal tissue is partially or completely extirpated and then the tooth is filled. These teeth could also be saved by a process of replantation in which case the affected tooth is extracted, cleaned, treated and inserted back into its original position. It is maintained by wiring/splints till it has stabilized. The carious tooth may be replaced by another otherwise healthy tooth such as embedded canine, or a wisdom tooth from the same individual. This is called autotransplantation. The affected tooth which otherwise cannot be treated should be extracted to control the carious process. Here under are noted complications of untreated caries:

1. Pulpitis is the inflammation of pulpal tissue in the tooth cavity. The tooth becomes very tender and there is a severe pain on taking drinks, especially the hot ones.
2. The pulpitis may lead to infection of bone around the apex of the root of the tooth.
3. The apical infection of bone may lead to the formation of an alveolar abscess.
4. An abscess can lead to a situation like cellulitis of floor of the mouth cavity causing asphyxia, i.e., choking.
5. The abscess may burst on the skin and form a sinus or sinuses. It may communicate with the maxillary antrum and form an oro-antral fistula.
6. The abscess can cause necrosis of bone, i.e., osteomyelitis of the jaws which means the bone becomes dead. The latter gets separated from the healthy bone and is either thrown out in small bits by the body itself or is removed surgically.
7. The infected tissue around the root tip of a tooth may degenerate in the centre and form a closed sac in the bone which is termed as a dental cyst.
8. The bacteria and their toxins from the infected carious tooth may enter the blood stream leading to becteraemia which may have deleterious effects on other organs or systems of the body (Fig. 3).

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Cromolyn use in ulcerative colitis

THE use of di-sodium cromoglycate or cromolyn (Intal) as an effective anti-asthmatic had been already discussed (Laha, N. N., *Science Reporter*, April 1976, p. 247). The drug di-sodium cromoglycate (DSCG) is a derivative of khellin, an active principle in a herb called *Amni visnaga*. Presently, DSCG has attracted gastroenterologists who have found out that this drug may also be beneficial for those who suffer from ulcerative colitis.

Ulcerative colitis is a disease of colon (large bowel) and rectum. It is a chronic, non-specific inflammatory disease. The cause of the disease is unknown. It usually starts in the rectum (then called ulcerative proctitis) and spreads towards the caecum. Age groups between 20 to 40 years are usually affected. The severity varies from person to person, from mild diarrhoea and occasional bleeding to severe and exhausting diarrhoea and signs of dehydration. The colon is inflammed and ulcerated with multiple bleeding points.

Microscopically, the disease is confined to the mucosa usually, rarely extending to deeper layers and shows inflammatory changes. There is an increase in the number of plasma cells, eosinophils and mast cells which have lost their granules. The histamine content of the colon is very high during a relapse. These changes are very typical of a type 1 hypersensitivity reaction (acute) and resemble those found in bronchial asthma. Since it is thought that some manifestations of ulcerative colitis are mediated by mast cells, gastroenterologists think that DSCG might be useful in treating this disease.

At present, the drugs that are used in the treatment of ulcerative colitis are steroids and a sulphonamide derivative called sulphasalazine. Steroids like prednisolone and prednisone are used as systemic agents. Locally, steroid suppositories (tablets to be inserted per rectum) and disposible steroid enemata are advised.

The use of DSCG in treating ulcerative colitis is being recently investigated. In a clinical trial, it was said (*Brit. Med. Journ., 1. p. 2* 1976) to have produced appreciable response in about 50% of cases. DSCG was given orally in a dose of about 300 mg/day and as an enema (200 mg) to 26 patients employing double blind cross over technique, with two treatment periods of four weeks. 14 patients (about 50%) showed considerable improvement and 10 had no benefits whatsoever.

Another paper by V. Mani and his colleagues which appeared in *Lancet* (28th Feb., 1976, p. 439), reports considerable improvement in the symptoms and signs of ulcerative colitis and proctitis (affecting both colon and rectum) following treatment with oral DSCG. The drug is not absorbed and acts topically. Both papers definitely suggest that DSCG may be of some benefit in the treatment of ulcerative colitis.

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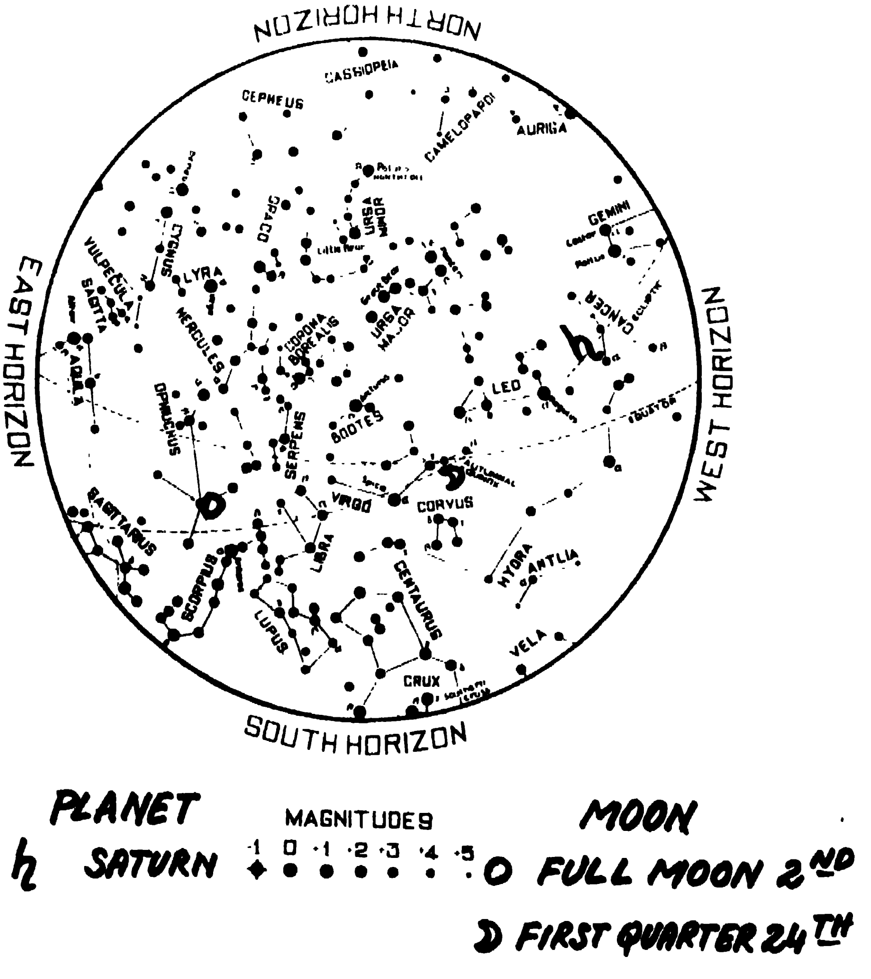
Planets and their positions

JUNE 1977



The moon

FULL moon occurs on 2nd at 2-01 a.m. and new moon on 16th at 11-53 p.m. I.S.T. The moon passes very close to Mars and also about one and a half degrees north of Venus on 12th, about two degrees south of Mercury on 15th and six degrees south of Saturn on 21st. The lunar crescent becomes first visible after the new moon day in the evening of 18th.

The moon is at perigee or nearest to the earth on the 1st and again on 30th and at apogee or farthest from it on 15th. The sun is at the summer solstice on 21st.

The planets

Mercury (Budha), a morning star, rises about an hour before sunrise during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It is in superior conjunction on 30th. It passes about five degrees north of the star Aldebaran (*Rohini*) in the evening of 16th. It moves from Aries (*Mesha*) to Gemini (*Mithuna*) through Taurus (*Vrisha*). Its visual magnitude varies from +0.5 to—1.1.

Venus (Sukra), visible in the morning sky, rises about two hours after local midnight during the month. It passes about a degree south of Mars on evening of 3rd. It is at the greatest western elongation of 46 degrees from the sun on 15th. It is in Aries (*Mesha*). Its visual magnitude is about—4.0.

Mars (Mangala), a morning star, rises about two hours after local midnight during the month. It is in Aries (*Mesha*). Its visual magnitude is about + 1.3.

Jupiter (Brihaspati) is too near the sun to be visible during the first half of the month. It is in conjunction with the sun on 4th. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It is in Taurus (*Vrisha*). Its visual magnitude is about—1.5.

Saturn (Sani), visible in the evening sky, sets about two hours before local midnight during the first half of the month and about three hours before it during the second half. It is an Cancer (*Karkata*). Its visual magnitude is about +0.6.

(*Source*: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N', New Alipore, Calcutta-53)

SCIENCE FOR THE YOUNG

Brain waves or EEGs

THE nervous system of the human body, in fact, of all animals, is a marvellous communication network of which the central exchange is the brain. All sensations, for example, the sensations of touch, hearing, sight, taste and smell etc., are communicated to the brain as electric impulses which travel along the nerves at a speed of about 100 meters per second. There is a gap of about two millionth of a centimeter at the point where one nerve ends and another begins. These gaps are called synapses and the nerve endings are called neurons. The synapses work because an impulse arriving at the junction between two neurons (i.e., nerve terminals) releases a chemical substance that crosses over the gap and activates the neuron on the opposite side. All this happens within a millisecond or so. The body uses in one place chemical and at another place electrical process to get nerve impulses underway.

The brain receives messages from different parts of the body through the nerves, and communicates its order to various muscles through another set of nerves called motor nerves. These nerve fibres emerging from the brain pass through the spinal cord and end upon various muscle fibres. There are again synapses between nerve endings and the muscle fibres.

The human brain contains approximately ten billion nerve cells, each of which can generate a sizeable electric discharge. Besides the nerve cells, the brain contains about 100 billion glia cells. Each glia cell is a miniature biological electric battery. It is indeed a marvellous feat of nature to successfully pack such an enormous number of electric generators inside the small human head and yet make them cooperate and collaborate with one another efficiently.

Some net electrical output from all these electrical generators, so tightly packed inside the brain, can be measured by recording devices such as those used on single cells. The electrical output of the brain is tapped off the skull by attaching electrodes to the skull and connecting them through amplifiers to a recording oscillogram which shows and records the ups and downs of the electrical output of the brain. These ups and downs (or fluctuations) of the electrical output of the brain are called brainwaves. The brain waves tapped off the skull of a man are one of the most dramatic demonstrations of bioelectricity.

Doctors call these brain waves Electro-Encephalogram (EEG) just as the recorded electrical output of the heart muscles is called electro-cardiogram (ECG). In 1875 an Englishman named Caton published the first description of these brainwaves or the ups and downs of the electrical output picked up by wires attached to the exposed brain of a dog. The EEG studies were begun in earnest by the Austrian psychiatrist Berger who published twenty research reports between 1929 and 1938. Since then, thousands of papers by scien-

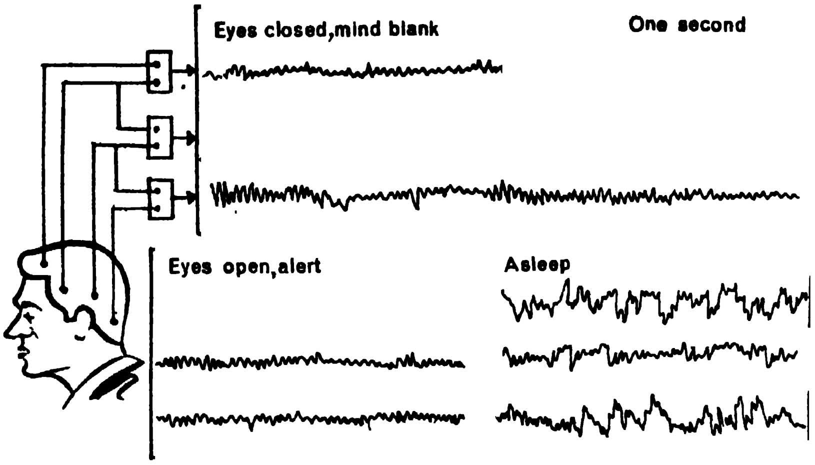


Fig. 1. Brain waves recorded simultaneously from front, middle and back of man's head. Waves from back of the head changed with subject's state of mind

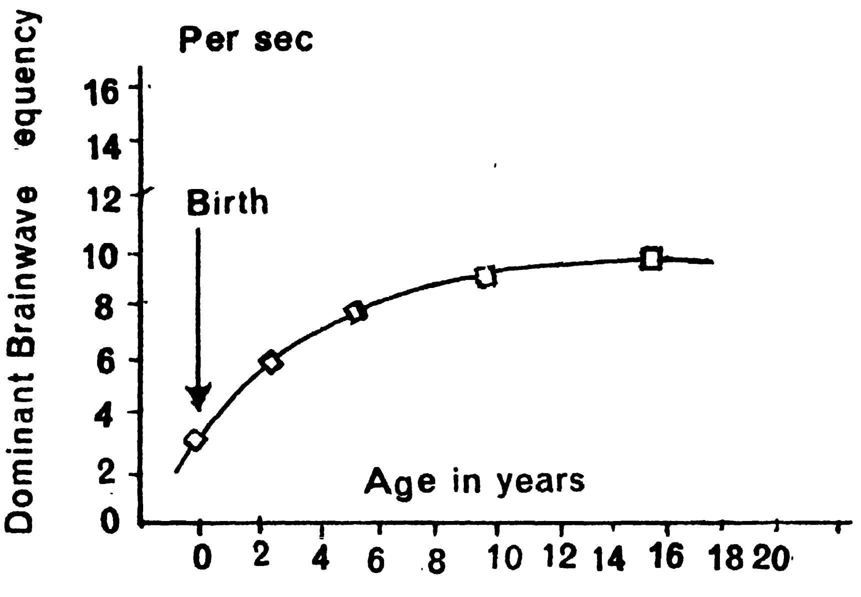


Fig. 2. Graph based on EEG recordings from hundreds of youngsters. Dominent EEG frequency rises is an orderly manner as children grow up

tists all over the world have filled the shelves of scientific libraries. Now-a-days, a close and intimate contact of the electrode, i.e., the wire terminal, with the brain nerves is not at all necessary. We have now vacuum tube amplifiers which can amplify a weak electrical output 10,000 times. They make it easy to detect and record human or animal brain waves from outside the skull through even a very thick layer of skin and bone.

In modern hospitals every day thousands of EEGs are taken from people asleep or awake, relaxed or excited, with their minds blank or solving knotty problems. A skilled expert can tell from the EEG record whether the person is awake, half asleep or deep in slumber. And often he can tell not only that a person is ill but also just what his disorder may be.

Fig. 1 shows sample EEG recordings illustrating their outstanding features. Each record is a graph of the voltage output of the brain during the measured time due to brain activity. The ups and downs in the graph are the waves and the distance along the graph measures the time. So by counting the number of ups and downs on the graph, over a length representing one second, one can measure the 'number of waves per second' which is called the frequency of the waves. The magnitude of the ups and downs, i.e., the amplitude of the waves is no less significant. If we count the number of waves per sec in various parts of the figure, we shall find the same to be at one place 10, at another 13, at the third place 2 and yet at another place 40. The counting of waves per sec or the frequency of the brain waves over a period of an hour or several hours is done by an electronic machine to find out how the frequency varies with varying mental states and moods. The frequency analysis of the brain waves by the electronic frequency analyses reveals many interesting and fundamental facts about the brain waves. For example, fig. 2 shows that the dominant frequency, i.e., the one most often found in the waking EEG of a person at rest depends very much on the age of the person. For children the dominant frequency varies from 3 to 5 per sec while in adults the same varies from 8 to 12 per sec. It is also known from such studies that the brain waves first begin to appear about three months before birth and they have a frequency of 1 to 3 per sec and are electrically very weak, i.e., the voltage output of the brain is very low. Newborn babies show waves of frequency 2 to 5 per sec with increased voltage output. The dominant brain wave frequency continuously and steadily increases as the child grows into an adult (Fig. 2) and reaches the maximum at about the age of 17. Attempt to relate this progressive rise in the dominant frequency to the changes in behaviour, interest and intellectual capacity as the child grows up to be an adult and beyond, form a fascinating chapter in the story of how physicians and psychologists use physical tools to understand biological processes.

The frequency of the brain waves generated during a period of several minutes can reveal some characteristic features. For example, Fig. 3 shows the frequency distribution of the brain waves of a person who during the recording was relaxed and awake, alert and attentive, or asleep. When awake frequencies round 10 per sec are present continuously. This normal rhythm of the brain waves is called the alpha rhythm. Inspite of the predominance of the alpha rhythm, frequencies around 5 per sec (called theta rhythm) and 20 to 25 per sec (called beta rhythm) also appear occasionally. When the person is alert the frequencies are mostly in the beta range. Besides human beings, animals like cats and monkeys show mostly beta waves in states of attention, problem solving and similar situations. During sleep the brain waves have frequencies of 1 to 5 per sec (delta waves). During a spell of moderately deep-sleep the brain waves have a frequency of 13 per sec. Fig. 4 is an imaginary analysis of the brain waves recorded from a normal person throughout a 24 hour period.

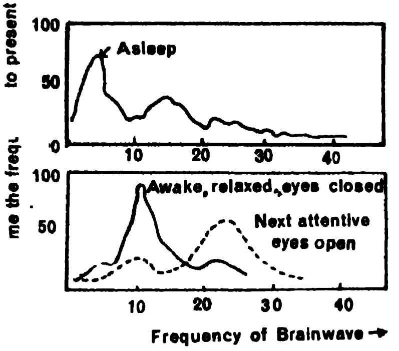


Fig 3.

To an astonishing degree the brain waves of all animals look alike. Approximately the same frequencies of the same amplitude are generated by the brains of all the higher vertebrates and most of the EEG variations occurring with emotion and action of a man show up also in similar situations in cats, dogs and monkeys. Relying on the similarity of EEGs of man and animals, most experiments are being carried on with animals in whose brains the EEG pickup wires are permanently embedded so that the experimenter can observe the electrical activity occurring at a particular place of the brain over a period of weeks or months. The experimental animal is thereafter put to death in a humane manner and the brain is prepared for study under the microscope.

Learning anything new must involve some reorganisation among the billions of cells inside the brain. The riddle of what becomes organised and how still remains to be understood and explained. Every animal including man is born with a basic pattern of behaviour determined by inborn instincts like hunger, self-preservation and the urge to reproduce the species. But every individual member of a given species modifies the basic pattern of its behaviour to adapt itself to the world it lives in, or in other words, it learns to live appropriately. The ability to learn is not limited of course to ourselves, but extends from the top to the bottom of the animal scale. Oysters and octopuses, parrots and elephants, one and all, form new habits, i.e., learn new patterns of behaviour as they grow up and gradually and progressively are exposed to their environment.

Some recent EEG measurements made on the brain, during learning, outline the newest and most exciting field of biological research. Change in the pattern of brain wave associated with learning was first studied over 40 years ago. At present scientists in many countries are trying new experiments to relate EEG to learning. In this worldwide research effort the EEG of fish, turtles, birds and cats and many other species of animals have been examined. Their efforts have disclosed many neat relationships showing EEG changes during learning. But the researchers admit that only the surface of the problem has been touched.

Yet most of them believe that by proper application of the techniques of physics and chemistry they will be able to understand the physical principles through which the brain cells drive the animals and human beings to do the many things they are able to do. Nevertheless, we are yet pitifully ignorant of how the brain works.

Perhaps a breakthrough will be achieved from experiments in which the brain will be studied not as a collection of nerves alone but as a community of nerve cells and glia cells snugly tucked inside the skull. Glia cells outnumber nerve cells by 10 to 1. Alongwith the neurons that they surround, the glia cells might even have an important role in generating EEG, the IPSP (Inhibitory Post-Synaptic Potential) and perhaps might even be involved in learning.

However thoroughly the human brain may be studied as a whole, however thoroughly it may be explored point to point by means of electrodes connected to the EEG machine, it seems that man will never be able to locate the seat of the master controller and director of the brain, I mean, the ego, the soul, the *Atman*, whatever you call it, who thinks, who wills, who creates works of art and science, who takes a particular decision in a particular situation to act in a particular way !

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Traffic inspector's problem

STANDING at a cross-road, a Traffic Inspector noticed three cars on his radar screen with a speed greater than the prescribed limit. He asked his constable to note the speeds. The constable noted the speed. But, being a cranky mathematician, he thought of testing the inspector's mathematics. He told him the speeds of the cars in the following mathematical jargon :

All speeds are in descending order and divisible by an odd number. This odd number is equal to the sum of two digits of the last car's speed. One less in a hundred gives the sum of two car speeds. Reversing the digits of first car gives second car's speed. Adding one hundred to each car's speed and then summing it gives a number equal to a section number. This section number is one under which a fraud case is registered. The difference between the digits of first car speed number gives the above odd number. What are the speeds of the cars ?

Solution

Suppose 1st, 2nd and 3rd cars have speed X_1, X_2, X_3 respectively.

$$X_1 + X_2 = 99 \quad \ldots (1)$$

Since the inspector states about the section number applicable for the fraud, and it is 420. So we get

$$(X_1+100) + (X_2+100) + (X_3+100) = 420 \quad \ldots (2)$$

By solving equation number (1) and (2) we get :

$$X_3 = 120-99 = 21 \quad \ldots (3)$$

The odd number is equal to the addition of third car speed, so it is $2+1 = 3$ ... (4)

Since all speeds are divisible by this odd number and none has got more than 2 digits, so:

$$\left.\begin{aligned} X_1 &< 99 \\ X_2 &< 99 \end{aligned}\right\} \quad \ldots (5)$$

Suppose $X_1 = D_3 D_4$ ... (6)

D_3, D_4 are two digits of 1st car speed.

By reversing these digits, we get second car speed

$$X_2 = D_4 D_3 \quad \ldots (7)$$

Since the difference of the digits of 1st car speed gives the odd number as obtained in equation (4), X_1 will have one digit an odd number and other one even number. It is also there in the question that it is divisible by 3, therefore :

$$\left.\begin{aligned} D_3 &< 9 \\ D_4 &< 9 \end{aligned}\right\} \quad \ldots (8)$$

Digits may be 3 or 6

D_3 may be 3 or 6

But speeds are in descending order so

$$D_3 = 6 \quad \ldots (9)$$

$$\text{and } D_4 = 3 \quad \ldots (10)$$

$$X_1 = D_3 D_4 = 63 \quad \ldots (11)$$

$$X_2 = D_4 D_3 = 36 \quad \ldots (12)$$

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Do it at your home

Positive feed-back recevier

IN the last issue, how to make a diode radio reciever not powered by any source of electricity was described. This radio can only work if it is near a radio station. For fringe reception a very long antenna would be necessary. Now, how to make a single transistor regenerative radio reciever which will give satisfactory reception in almost any part of the country except the fringe areas is described below.

A germanium high-frequency transistor AF117 is used as per the circuit given in Fig. 1. Part of the output, it could be seen from the circuit, is fed back in phase with the input through a tickler coil. The feedback is controlled with a potentiometer, otherwise the circuit will behave as an oscillator with a high feedback and high input.

The input is taken through a padder capacitor C_1. 500F and is fed back to the tuning assembly C_2, L_1. L_1. is inductively coupled to the feedback coil L_2. From here the input goes to the detector/amplifier trans-

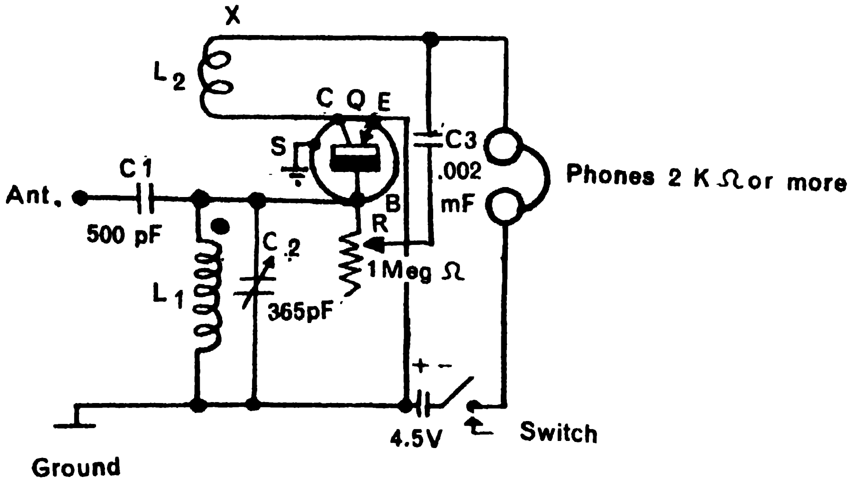

Fig. 1 Circut, C_1 : 500pF padder; C_2: 365 pF variable; C_3: .002 μF ceramic : R: 1 Meg linear potentiometer (use the centreterminal and anyone of the other too; Q:AF 117: L_1, L_2 Ref. text Fig.2; Cell:4.5 (3 Penlight); Switch:toggle

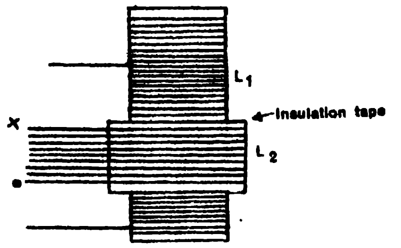

Fig. 2. Coil assembly: L_2 : 40 turns # 32, L_2 40 turns # 32 on one end of L_1 and in the same direction, coil from: 2.5 cm dia. plastic tube

istor Q through the capacitor C_3. Part of the output from this common emitter setup is fed back and the rest goes to the headphone.

The high sensitivity of the circuit is due to the positive feedback. As a part of the amplified signal is fed back in such a way that it strengthens the original signal, even a weak signal is fortified. Excellent fringe reception is therefore possible.

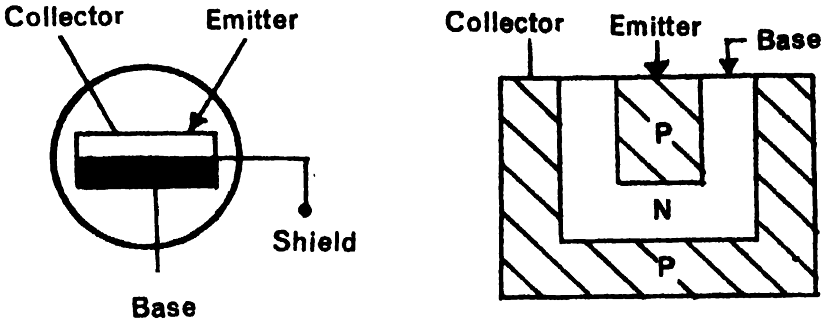

Fig. 3. (i) p-n-p transistor

The circuit has its attendant problems. Any hum or noise in any part of the circuit is also fed back and correspondingly strengthened. So therefore it is advisable not to operate this radio receiver on an eliminator, as the mains hum of 50 Hz would then be audible and annoying. A good grounding is also necessary, preferably a water tap or a metal spike in the ground, and be sure to connect the shield terminal of the transistor (marked S) to this ground.

The coil has to be hand-wound. On a 2.5 cm diameter plastic tube, wind 144 turns of No. 32 enamelled copper wire neatly. Over one end of this coil, wind a single turn of insulating plastic tape. On this insulation, wind 40 turns of the enamelled copper wire in the same direction as the coil underneath. Fig. 2 shows a schematic representation of the coil, as proper phasing of the feedback is necessary: the proper ends (marked by a dot and a cross) must be connected to the proper points (correspondingly marked by a dot and a cross) in the circuit.

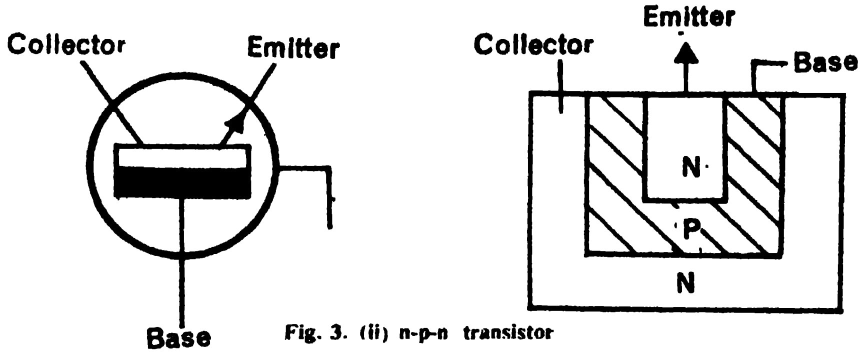

Fig. 3. (ii) n-p-n transistor

The headphone is one with an impedance of 2 kilo-ohms or more. It has already been described in the previous issue (S.R. April, 77) in some detail.

The tuning condenser is a standard 365pF tuning unit, usually available in a combination of two in a housing operated by the same knob. There are three terminals outside. Use the centre one and any one of the other terminals.

A transistor has three components. In a P-N-P transistor there are two layers of P-material (a technical term: it just means silicon or germanium with some metallic impurity of valency 3) in between which there is a layer of N-material (silicon/germanium with some metallic impurity of valency 5.) In an N-P-N transistor it is the other way round. The middle layer is called the base and the outer ones the emitter and the collector. In Fig. 3 (i) and (ii) the emitter has an arrow on it, pointing inwards in a P-N-P transistor and outwards in an N-P-N one.

If a signal is imposed across the emitter and the base, and if for a P-N-P transistor the emitter is positive W.R.T. the base and the collecter negative, then an amplified signal is available across the collector and the emitter. For and N-P-N transitor, the polarities are inverted. If you are not conversant with a transistor, the base diagram of the transistor is given (Fig 4) indicating the base, the emitter, the collector and the shield terminals.

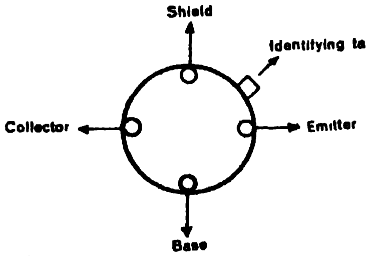

Fig. 4. Bottom view of AF 117

Use a 1 megaohm linear potentiometer for R.

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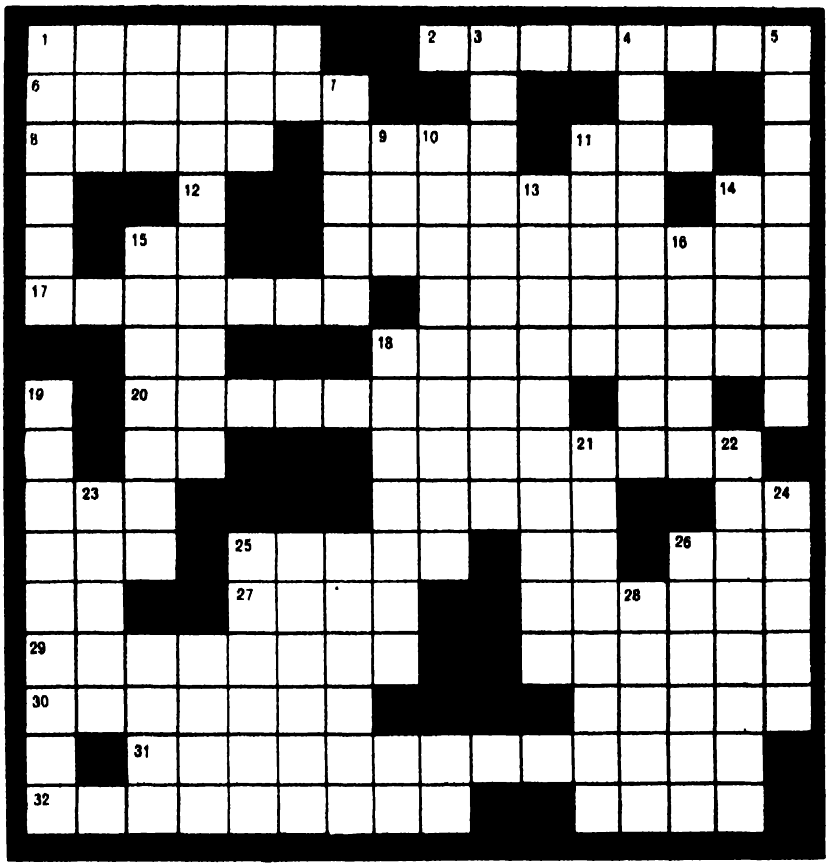

Science Crossword Puzzle (Entomology)

CLUES

Across

1. First Imperial Entomologist at Imperial Agricultural Research Institute, Pusa (Bihar).
2. An alternative name for the class Insecta.
6. An egg case or capsule, formed by hardening of a stickly secretion from the collecterial glands.
8. Generic name for bed bug.
11. An organic contact insecticide.
17. The breathing tube of insects.
20. A V-shaped cuticular plate supporting the elongated labium of a bee or a similar insect.
25. The hairs of insects formed by cuticle.
27. Destructive insects of crops, etc., are commonly called....
29. Name of the vector of protozoan which causes sleeping sickness.
30. The cells which, by division, give rise to oocytes and hence to ova.
31. A rapid and complete transformation from larval to an adult form.
32. Term for production of males and females parthenogenetically.

Down

1. Common term used for migratory grasshopper.
3. Outer layer skin of an insect, made of sclerotin which is impervious to water.
4. Generic name for human body louse.
5. Type of antenna present in housefly.
7. A part of an insect's wing forming a small separate lobe close to the body.
9. Abbreviation for a contact insecticide.
10. Family to which migratory grasshoppers, having shorter antennae, belong.
11. Male bee which develops by parthenogenesis.
12. A protective covering for the pupa of an insect.
13. When two squamae are present on the inner side of alula, the one nearest to the alula is known as ......
14. First segment of the insect's leg.
15. Name of a mimic butterfly.
16. The adult form of an insect after metamorphosis.
18. Name of order to which fastest flyers belong.
19. Group of insects which have wings.
21. Emergence of adult from pupa is also known as..........
22. The stage at which slowing down of metabolism and delay of development of insect takes place.
23. Generic name of 'Jowar' borer.
24. The fertile female in a colony of termites capable of laying eggs.
26. Type of image formed in the compound eye.
28. Young worker bee engaged in the feeding of larvae.

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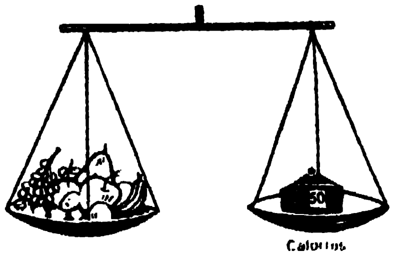
FOR HER

Lal sag

WHAT you call in Hindi *Lal sag* or *Chaulai sag* is botanically *Amaranthus gangeticus*. In Kannada, Telugu and Tamil it is respectively known as Dantu, Tola Kura and Mulai Keerai. There are in fact a total of 60 species of the genus *Amaranthus*, out of which 25 are grown in India. What is the nutritive value of this herb? Like other green, leafy vegetables it is rich in vitamin A and iron. Some of the much valued contents per 100 grams of this, vegetable are: vitamin A-9200 IU; Vitamin C-99 mg; iron 25.5 mg; calcium-397 mg. And undoubtely it is good for children, pregnant women and nursing mothers.

Caloric requirement

THE food we eat supplies energy required by us for physical and physiological processes such as cellular functions, heart beating, brain function, etc. The energy value of a food is assessed in terms of calories. The caloric value of different foods is known. For example, some of the foods per 100 grams have caloric equivalent as follows: cereals and millets 360; pulses-350; vegetables-25 to 50; fruits 25 to 50; root vegetable and tubers-90 to 150; butter, ghee and oil-900; and milk, mutton and egg-60 to 180. By knowing caloric value of each of the food items, one can calculate a man's or woman's daily caloric requirements and balance the food accordingly. But, what are the caloric requirements of average Indians of different ages and sexes?



It is as follows:

Man

Sedentary work	2,400
Moderate work	2,800
Heavy work	3,900

Women

Sedentary work	2,000
Moderate	2,300
Heavy	3,000
Pregnant	2,300
Nursing	2,700

Children

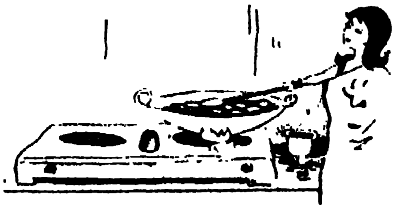
0-6 months (per kg.)	120
7-12 months (per kg.)	100
1-3 years	1,200
3-6 years	1,500
6-9 years	1,800
10-12 years	2,100

Adolescents

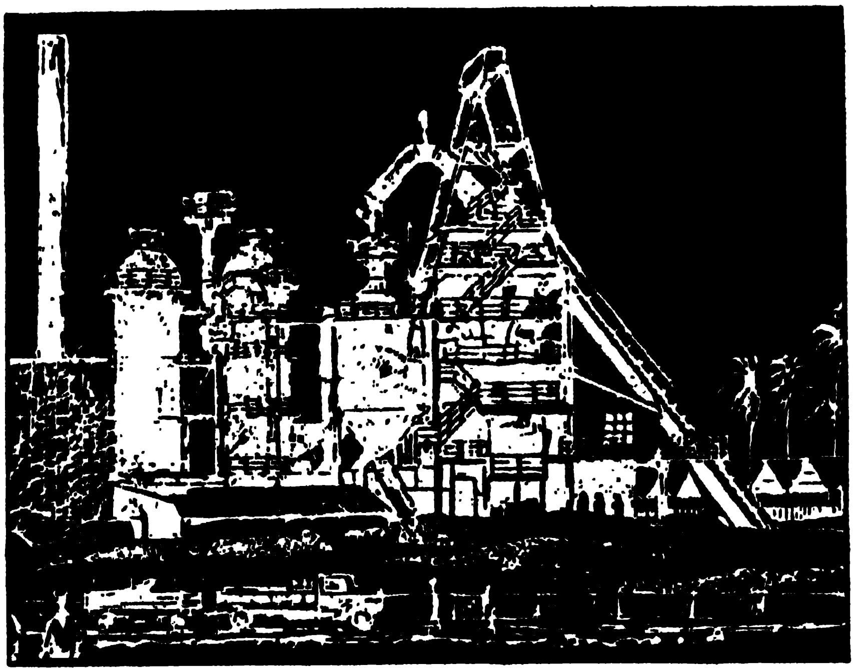
13-15 years	Boys	2,500
16-19 years		3,150
13-15 years	Girls	2,100
16-19 years		2,100

Fried foods

A HOUSEWIFE knows that several delicious dishes cannot be prepared without the use of fat or oil, which are subjected to heating during the process of cooking. But do you know that heating oil or fat brings about some chemical changes which may prove harmful to health? Some of the unsaturated fatty acids in most of our oils and fats are known to be essential for man. The unsaturated fatty acids, however, react with oxygen of the atmosphere and form oxidation products known as peroxides, many of which are injurious to health. The peroxides further decompose to form other compounds which are equally injurious. Also, at a high temperature the molecules of fats, or oils join together to form complicated and larger molecules by the process of polymerization. For example, in the preparation of fried food such as *puris* the oil may get over heated and be polymerised. The polymerised oil is hard to digest, and it invariably leads to indigetion. Prolonged heating, high temprature and reuse of left-out oil are inadvisable and should be avoided while preparing fried-foods.



ZAKA IMAM



SCIENCE IN INDUSTRY

Electrolytic colouring of aluminium and its alloys

LESS than a century ago, aluminium was considered one of the rare metals. It was so precious that Napolean III of France considered it more prestigious to serve food in aluminium dishes instead of in gold dishes when entertaining the King of Siam in 1886. However, aluminium is now one of the most easily available metals, and takes its place next to steel in abundance. On account of the comparative corrosion resistance of aluminium, it is being increasingly used for decorative and architectural purposes. Specially, coloured aluminium articles are very much in demand for such uses.

There are two processes by which aluminium and its alloys can be given a coloured oxide film: (i) the anodized material is coloured by dipping in a suitable dye for sufficient time and under optimum conditions before sealing, and (ii) purely electrolytic processes by which the colour is developed either during the anodizing itself, or subsequently by electrodeposition of metal ions onto and into the film from various metal salt solutions. Either, A.C. or D.C. or a mixture of A.C. and D.C. can be used for either of these electrolytic anodizing, colouring processes.

Integral colour anodizing

Most of the integral coloured finishes are made with the following four processes:

(i) *Conventional sulphuric acid anodizing.* This process produces "clean" or "natural" coloured coatings on commercial aluminium, but on alloys containing Si and Cr. The colours produced are grey and yellow respectively.

(ii) *Hard-coat sulphuric acid anodizing.* This produces harder and more abrasion-resistant coatings than those produced by the conventional sulphuric acid method by using low temperatures and higher current densities. Colours produced are yellow, bronze, black, etc.

(iii) *Oxalic acid anodizing.* This is less common because of higher cost than sulphuric acid processes. The colours produced are also similar as those produced by the sulphuric acid processes.

(iv) *Organic sulphonic acid anodizing.* These processes are known under various trade names as "Kalcolour", "Duranodic", "Reynocolour", "Permalux", and "Autocolour HSH", etc. Excellent coatings as regards variety of colour, hardness, colour fastness and other desirable properties can be produced by this method with colours ranging from yellow, amber, bronze, gray to black (Table 1).

In the single step integral colour anodizing process, the production of different colours is possible with a proper combination of anodizing electrolytes and the compositions of materials to be anodized apart from various variable parameters.

The presence of alloying elements in excess of the permissible limit may result in undesirable effects during anodizing.

Out of the electrolytes mentioned above for integral colour anodizing, the organic sulphonic acid group alongwith Periodic Table group VI B anions specially molybdates and tungstate present a large variety of organic acids and compounds which serve to produce over and above the now familiar brown toned and black coatings—additional colours like blues, greens and grays with considerably less dependance on the basic alloy composition than in conventional sulphuric acid and oxalic acid processes. Several additions have been employed in the anodizing baths to obtain various colours and beneficial effects.

A list of aluminium and its alloys suitable for decorative, general purpose and architectural anodizing with the details of operating conditions in the conventional, and complexing and non-complexing type of electrolyte can be found in any good and up-to-date work on anodizing. Some of the typical compositions are as follows:—

Table 1

Alloy	*Primary element%*	*Oxalic acid*	*Sulphuric acid*
99.99 Al	Trace of iron	Pale straw	Clear transparent
1100	About 0.4 Fe, 0.4 Si	Pure grey gold	Silver grey
3003	1.25 Mn	Brown	Pale brown
5052	2.2 Mg, 0.2 Cr	Golden bronze	Silver light yellow
6063	0.7 Mg, 0.5 Si	Pale gold	Silver
6061	1.0 Mg, 0.6 Si 0.25 Cr, 0.25 Cu	Dark brown	Yellow
2014	4.0 Cu, 0.6 Mg, 0.5 Mn	Bluish white	Bluish yellow
5086	4.0 Mg, 0.5 Mn	Brownish yellow	Silver grey
4043	5.0 Si, 0.5 Fe	Grey Bronze	Gray

Anodizing and colouring by electrolysis

The process of colouring the anodized material by subsequent electrolysis is of a more recent origin. Recent literature on anodizing is flooded with patents on electrolytic colouring of anodized aluminium. The relative simplicity of the electrolytic colouring technique, the relatively inexpensive equipment required and the excellent properties obtained with these finishes has led to a rapid growth of interest in the process.

In this process, the anodized material is immersed in an electrolyte containing one or more of the salts of Cu, Sn, Co, Ni, Cr, Fe, Ag, Pb, or a manganate, tellurite or silenite. An alternating or direct current or superimposed on A.C. is used to effect the electrolysis resulting in coloured films such as gold, greyish blue, blue bronze, black, etc., which are then sealed in the usual way. By this method, very thin coatings can also be coloured to the same depth of colour as thick films.

The various colours obtained on aluminium and aluminium alloys enhance their use mostly decorative applications. Being a decorative civil engineering aspect of building, the coloured aluminium and its alloys have been extensively used in architecture especially as anodized colour aluminium is weather resistant, and is available at reasonable cost. Some of the most common applications in this field are: wall grids, panels, industrial roofing and siding, monumental residential and indusrial windows, shop fronts, office partitions store fronts, etc.

The uses of integral colour anodized and electrolytically coloured Al and Al-alloys have not yet been fully exploited in India, although in European countries the colour anodized products are being extensively used for a multitude of applications including decorative and architecutral.

Colour anodized Al and Al-alloy sheets can successfully and economically replace the galvanized iron and tin sheets as materials of construction for various purposes.

In India, although the electrolytically coloured Al and its alloys have hardly crossed the threshold of laboratories, it has a bright prospect for use in decorative and architectural fields as its technology is in the developmental stage. New and specialised techniques are being invented, as the need arises, enlarging the scope of the application of colour anodized aluminium products.

There is ample scope for its development for uses in various fields. The integral colour anodizing is a definite advancement in the technology of colour anodizing and it has made spectacular progress in a short time. The process of organic sulphonic acid anodizing for electrolytic colouring of aluminium and its alloys is a great achievement in this field as this has made

Table 2

Composition of Al and Al alloys	*Electrolyte and bath composition*	*Anodizing conditions*	*Colour and remarks*
KS45 (5005)	2. 6-dihydroxy benzoic acid + H_2SO_4	2, 4 A/dm^2 25° C, 30 min. 90 V max.	Black 5 mm thick
KS45 (5005) 6061, 1199	Ammonium para molybdate + H_2SO_4 + oxalic acid	2A/dm^2, 25° C, time varied according to thickness desired, 70 V max.	Blue, dark-blue, green and black with non aq seal and brown to black with aq seal 0.6-1.4 mil.
Al or Al alloys (5005)	2.7% ammonium para molybdate 1.65% sodium tungstate + 0.5-8% H_2SO_4 + 0.5-4.5% oxalic acid	0.5-3A/dm^2 25° C, 90 min. 30-100 V max.	Dark blue colour unrelated to alloy composition
Cast alloy (Be 0.05-2% and Fe + Si 1%)	10% sulphosalicyclic acid + 0.5 H_2SO_4	300A/dm^2 20° C, 45 mins.	Amber
A-SGM (1% of Si, Mg, Mn) and others	5-20% sulphomaleic acid + 0.05-0.8% H_2SO_4	1-4A/dm^2 15-30° C, 30-60 min.	Light bronze to black films
KS 32 (1100)	3, 5-dihydroxy 4 carboxy toluene, 6-disulphonic acid + H_2SO_4.	24A/ft^2, 25° C	Dark brown colour with Fe^{+3} deep red/blue

available to users a spectrum of colour products so appealing, economical, durable and easily within the reach of masses.

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NAL develops low-power wind electric generator

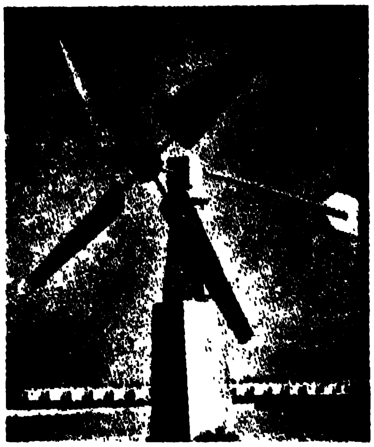
THE National Aeronautical Laboratory (NAL), Bangalore, has designed and developed a wind electric generator to serve as a source of electricity alternative to dry cells which are essential in operating isolated electronic system. As and when the wind energy is available the wind electric generator charges a long life battery from which the energy can be drawn.

The wind generator has been designed with emphasis on least maintenance and has the following features: (i) the blades are made of an aluminiuim alloy and resist corrosin; (ii) the blade assembly has a feathering: mechanism to reduce the angle of attack for high wind speed; (iii) the head assembly is totally enclosed and the steel parts are painted with oven baked epoxy paint; and (iv) the electric generator is coupled such that slip rings and brushes are avoided.

The device is capable of producing better than 20-30 VAhr of energy on a wind day and is an economically viable alternative to the dry cell. Prototype tests are under way.

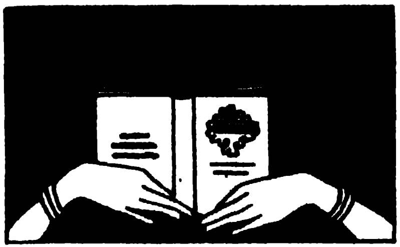
The specifications of the wind electric generator are:

Type	: MP 30
Propeller diam.	: 2 m
Number of blades	: 4
Rated speed of propeller	: 150 rpm
Rated wind speed	: 7m/s
Cut in wind speed	: 3.5 m/s
Rated power of generator	: 30W
Output of system	: 4V
Energy storagec apability of battery	: 24VAhr
Output energy on a typical windy day in Bangalore	: 20VAh



Low power wind electric generator developed by NAL, Bangalore

The generator will find application in aviation lighting on remote features, navigation buoys on seaways, repeater stations for telecom equipment, radio reporting rain gauge stations and similar automatic measuring systems, and power source for radios in isolated windy locations.



BOOK REVIEWS

COMPUTER POWER AND HUMAN REASON From Judgement to Calculation by Joseph Weizenbaum, *W. H. Freeman & Co.*, 660, Market Street San Francisco California, 94104 (U.S.A.) Pp. 300, $ 9.95

WHETHER you are a computer programmer thrilled by the efficiency or accuracy of computer, or you are a business administrator more so ever relying on computers for decision-making or production, or you are a man on the pavement day-dreaming that one day computer would do all your job while you take a nap, beware of the silly impression you might be carrying about computers, that they are getting more and more powerful and the day is not far away when they would replace human beings. This is what, in short, Joseph Weizenbaum, the author, tries to say in this book. Though like the title the book is erudite in content, the subject as complex as computer science has, however, been broken down into such bits as to be understandable to any one knowing elementary mathematics.

In the introduction the author, who is a Professor of a Computer Science at M.I.T., Massachussetts, tells how he was inspired to write this humanistic book. It started off when he made the computer, chrisened ELIZA, which could respond to people within a limited language vocabulary. As the computer used to respond by taking hint from the things said to it, it soon attracted notice as a psychotherapy tool. That ELIZA could replace psychotherapists in curing mental ailments became a popular belief overnight. No time was lost then by computer scientists to declare with more vehemence, though the belief had already been in circulation for more than a decade, that computer would one day replace engineers, doctors, artists, etc., and eventually the man himself.

The author was overwhelmed by such statements and to argue himself out he wrote this book, saying with all the force that computer could never replace human beings. In about 280 pages, he uses all his experience with computers and people to drill into one's mind this seemingly inevitable belief. He weighs the significance of computer in all perspectives such as moral, ethical, social, emotional, etc. To prop up his arguments he quotes various authorities and discusses the pros and cons of the said things.

While in the first nine chapters, the author drives home his views as to what computer can do and cannot do with his lucid and powerful expression, in the last chapter he makes a sort of appeal to computer programmers and technologists not to put computer to destructive uses. From the recent events, such as Vietnam war, etc., discussed in it, one gets the impression that the rise of computer is the downfall of human race.

The book, to be frank, would be of interest to those who harbour a love for philosophy not necessarily science-interested intelligentsia.

DILIP M. SALWI

GENETICS AND BIOCHEMISTRY OF PSEUDOMONAS Edited by P.H. Clarke and M.H. *Richmond, John Wiley and Sons* pp. 366, $39.95; *Indian Representative* : Wiley Eastern Bookshop, 4654/21, Daryaganj New Delhi 110002

THE bacteria belonging to the group Pseudomonas are of considerable scientific and practical importance with respect to human pathogenesis and indusrial microbiology. The above book has been produced with the cooperation of nine contributors and their effort seems to be impressive. The fields covered are microbiology, medical aspects, genetics, biochemistry and molecular biology. *E. coli* is the only bacterium which has been studied very extensively; and when other bacteria are studied, *E. coli* is used for comparison. The organization of genetic material of the bacteria is discussed in detail here and a comparison is given with the arrangement of genes on the chromosome with that of *E. coli*. Studies with a number of Pseudomonas species have provided valuable contributions to the understanding of biochemical pathways and this has been dealt well. Those interested in plasmids will find this book very informative.

The last chapter discusses the possibilities of fundamental contributions which this organism can make on molecular biology together with solving problems like biodegradation of organic molecules introduced into natural environment by man. It is only during the last few years that scientists have focussed attention on this group of bacteria and the information compiled here will be useful to advanced students and research workers in microbiology.

The layout of the book is pleasing; the informations is presented well with a factual approach. The bibliography at the end of each chapter is useful and the index satisfactory.

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MODERN IMMUNOLOGY by A. Dasgupta, 1976 Edition, *Tata McGraw-Hill Publishing Company Ltd.*, Asaf Ali Road, New Delhi-1 Pp. XII+318, Price : Rs. 21.00.

ALTHOUGH there are many books on immunology—both basic and applied—written by experts the world over, the book under review is the first comprehensive book written by an Indian author on the subject. The author is associated with the subject at the Department of Microbiology, All India Institute of Medical Sciences, New Delhi.

The tissues and cells capable of exhibiting what is now recognized as an adaptive immune response have an evolutionary history of some 400 million years. The meaning of the term immunity, as it is used today is derived from its earlier usage meaning exemption from military service or paying taxes. Immunology as a science began with the demonstration in 1890 by von Behring and Kitasato at the Koch Institute in Berlin, of an antibacterial substance or factor in the blood, now known as antibody globulin, of animals immunized against tetanus and diphtheria organisms.

The book has been divided into eleven chapters starting with a historical background of this branch of science. In England, the procedure of cow-pox vaccination developed by Edward Jenner in 1798 for protection against smallpox and that used by Francis Home in Edinburgh for measles protection were essentially empirical measures performed without understanding the underlying principles. The discovery of the tubercle bacillus by Robert Koch led him to describe the phenomenon of delayed hypersensitivity or cell-mediated immunity as it is known today.The principles underlying the above phenomena are described clearly and systematically in the next four chapters on the process of immunological response and interaction between antigen and antibody. The following chapters describe the role of immunology as used in health and disease, These describe in a simple manner the understanding of immunological processes underlying the reaction of the body to tumors, to transplanted tissues and organs, and to infectious agents. It provides various laboratory techniques on preparation of lymphocytes, distinction between T - and B - cells, and *in vitro* tests used to demonstrate antibody production and cell-mediated immunity. Each chapter is further made more understandable by providing diagrams and tables. It has an excellent further reading references covering literature upto 1975 at the end of each chapter. It has also a number of black and white plates showing antigen-antibody complex, macrophage, T-and B-cells, macrophage migration inhibition test, lymphoblast, etc.

It is written in a simple language and is sufficiently broad in scope and fundamentals to give the students of medicine a firm foundation before proceeding to a more advanced work in the field.

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GENETICS by P.S. Verma and V.K. Agarwal, *S. Chand and Co.*, Ram Nagar, New Delhi-110055. Rs. 11.00,

THE science of genetics has gone a long way since the days of Gregor Mendel. After Watson and Crick came out with the structure of DNA and RNA in 1962, it became apparent that man could, sometime in the future, tamper with the basic nature of all living beings including his own species.

Also, an understanding of the biochemical basis of heredity would enable biologists to study the processes of growth and reproduction. No wonder then, that genetics has emerged as a major discipline and has been introduced at the undergraduate and the post-graduate levels for students of biology. This book is one of the first Indian textbooks to appear on the subject. Perhaps that is why the book covers a wide range of the subject—starting with the elementary concepts about the laws of inheritance and gradually going into the biochemical complexities at the molecular level. Beginning with Mendel's experiments, it goes on to discuss at length, the nature of gene action. Being accompanied as it is, with rather expressive diagrams and elaborate examples to illustarate all basic principles, it would be a good textbook for B.Sc. (General), B.Sc. (Hons), B.Sc. (Agriculture) and even M.Sc. students. Teachers at the Higher Secodary level, who probably never had genetics in their syllabi, would find it of great value. The book is reasonably priced.

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CYTOGENETICS, PLANTBREEDDING AND EVOLUTION by U. Sinha and Sunita Sinha, *Vikas Publishing House Pvt. Ltd.*, 5, Ansari Road, New Delhi-110002, 1976, Pp. 396, Rs. 22.00.

MANY new books dealing with different science subjects are appearing in the Indian market. Some of these books contain material copied from foreign books, while others contain material modified from the original. The latter books, instead of being made easy to understand, are made more confusing by the authors because of their lack of understanding of the subject and lack of expression. The book under review, however, is free from any of the above mentioned defects, as it has been written by two persons who have the clear background of the subject owing to their research and teaching experience.

This book is a store of information for graduate and post-graduate students of agriculture, anthropology, botany and zoology. It contains in a single volume the classical and the modern works in the field of cytogenetics, plant breeding and evolution. The book is well illustrated by means of photographic plates and self explanatory diagrams. The reproduction of the photographs, however, is poor and there are many typographical errors. The authors have divided the book into 21 chapters and devoted 9-18 page to each chapter. They have explained in a lucid language and in a coherent and interesting manner the different topics in each chapter. Apart from these informative chapters there are some model genetical problems, a supplementary reading list spread over 14 pages and an index of 18 pages.

In this book, the students can find topics that were so far found in books dealing with molecular genetics and biochemistry. Recent additions to our knowledge of genetics at molecular level such as Meselson and Stahl's experiment on DNA replication, transcription, genetic code and codon assignment in amino acid synthesis and Taylor's experiment showing semi-conservative replication of the chromosomes are also dealt with in the book, thus saving the trouble of consulting other books.

The book also enlightens us on the changing concept of the gene since the time of Mendel. The experiments of Beadle and Tatum demonstrating 'one gene-one enzyme' theory and those of Yanofsky et al., regarding one cistron-one polypeptide' and the colinearity of the gene and the polypeptide are some new aspects in genetics given in this book. The breeding and improvement of some crop plants such as rice, wheat, maize, sugarcane and potato form one of its chapters.

The authors have made a passing reference to parasexuality and the possibility of protoplast fusion as an aid in hybridisation of animals and plants. These topics could have been elaborated further since plenty of work has been done in these fields. The book in general is highly useful for graduate and post-graduate students, but is out of reach of many because of its high price even though it is printed on subsidised paper.

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Alipore, Delhi-36

BOOKS RECEIVED

1 **QUANTUM MECHANICS** (2nd Edn.) by A. S. Davydov, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. $ 636,

2. **PHYSICS IN INDUSTRY** Ed. by E.O. Mongain & C.P. O'Toole, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 595, $ 30.00

3. **GRAVITATION AND RELATIVITY** by M.G. Bowler, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OEW, England, Pp. 172, $ 14.50

4. **INTRODUCTION TO GENERAL RELATIVITY** by H.A. Atwater, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OBW, England, Pp. 221, $ 13.00

5. **HANDBOOK OF THICK FILM TECHNOLOGY** by P.J. Holmes and R.G. Loas by *Electrochemical Publications Ltd.*, 29, Barns Street, Ayr., Scotland KA7 1XB, England, Pp. 430, $ 57.50

6. **LABORATORY MANUAL OF INORGANIC CHEMISTRY** by H.M. Chawla, A.C. Handa, R.C. Rastogi, *Sultan Chand & Sons.*, 4792/23, Daryaganj, New Delhi 110002 Pp. 185, Rs. 5.00

7. **B.Sc. PROBLEMS IN PHYSICS** by Dhar, Sehgal and Chopra., *Sultan Chand & Sons*, 4792/23, Daryaganj, N. Delhi-110002.

8. **DO IT YOURSELF RADIO** by Bhavnani, *Hind Pocket Books* Rs. 5.00

9. **ENGLISH FOR TECHNICAL STUDENTS** by R. Sundasanam, *Tamil Nadu Agricultural University.*, Agricultural College and Research Institute, Coimbatore-641003, Books I, II, III, Pp. 138, Pp. 152 Pp. 154, Price not indicated.

10, **OBJECTIVE TYPE NUMERICAL PROBLEMS IN PHYSICS AND CHEMISTRY** by M. N. Verma and A. Yadav, *R. P. Shrivastava & Sons*, Kazipur, Patna-800004, Pp. 308, Rs. 20.00

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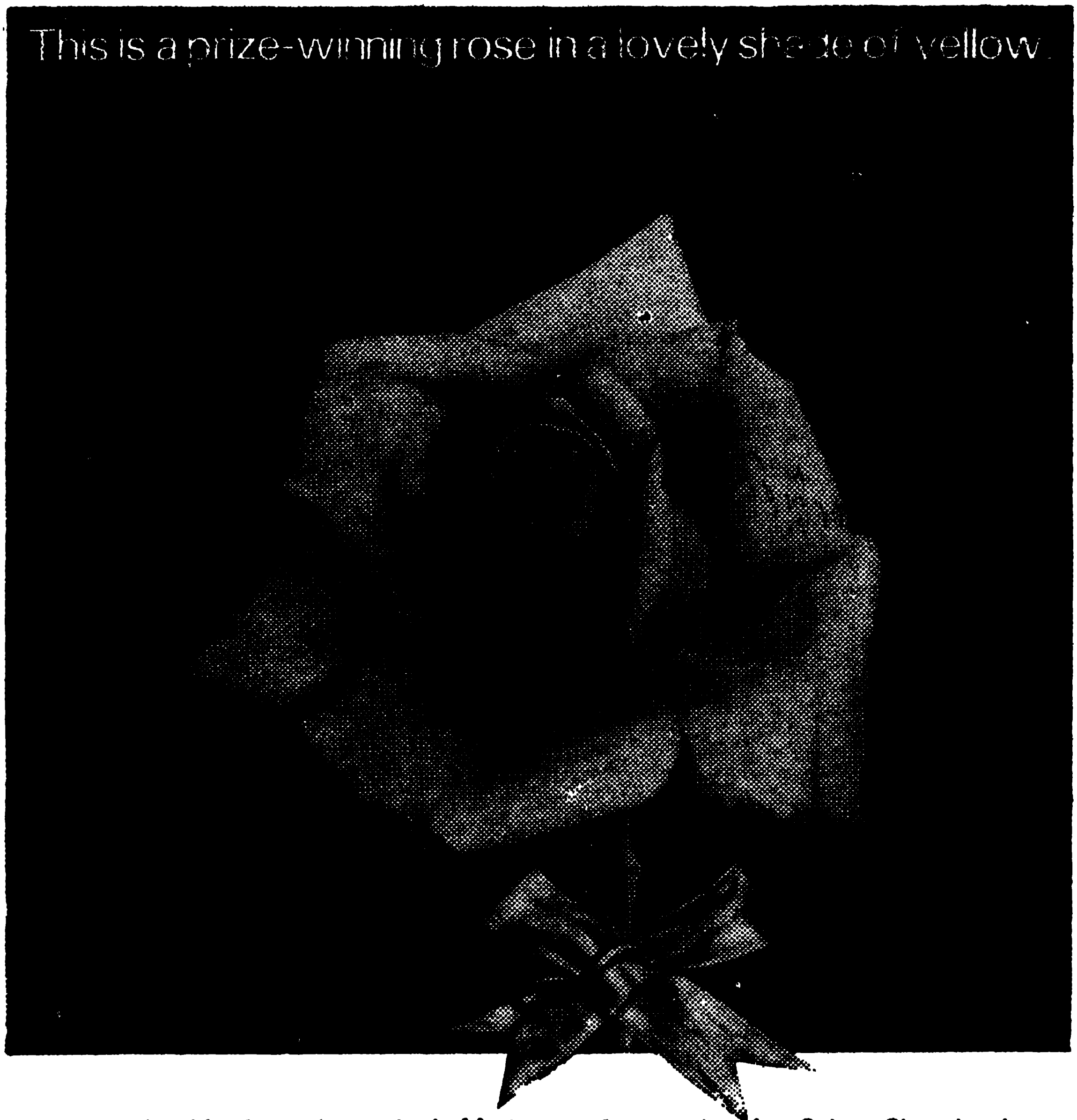

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Cover: Male caribou at the Boston Zoo bearing a prominent palmate brow tine

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LETTERS

The strange world of viruses

Sir, In "Science for the Young" S.*R*., September 1976) the author as mentioned that viruses were ucleic proteins containing RNA or NA or both. This is not orrect, as viruses contain either NA or DNA, but certainly not oth. This important difference stinguishes viruses from other icroorganisms which contain both NA and RNA.

Nothing has been mentioned out the highly fatal rabies sease caused by a neurotropic yxo virus. All warm-blooded imals including man are suscep-le to this infectious disease, ich is primarily a disease of dogs, lves and jackals and transmitted other animals by bites. In human ings this disease is referred to as drophobia.

In South America, the blood-king vampire bats are known to reserviors of this virus. They nsmit the virus to human beings l animals while biting and sucking od. Dogs carry the virus in saliva hout exhibiting in the least the ical symptoms of rabies. It was orted that a dog lived upto two rs carrying the rabies virus with- actually suffering from the ase. Hence all dog-bite cases spective of the fact whether the s are rabid or non-rabid should treated immediately for anti-ies therapy; this disease is liable spread quickly. Once the dis- sets in there is no cure at all for the patient, and his sufferings are dreadful and heartrending.

S. AYYAMPERUMAL
Asstt. Lecturer
Department of Physiology
Madras Veterinary College
Madras-7

Ascorbic acid

Sir, I read the article, **Deterioration of ascorbic acid in diseased fruits** by D. P. C. Rao (*S.R.*, Feb. 1977) with interest. I would like to add the following points.

The nutritive value of fruits and vegetables depends largely upon their vitamin C (ascorbic acid) content. Of the common Indian fruits, mango, papaya and *Litchi* occupy an important position as sources of ascrobic acid.

R. H. Singh (1968) of Allahabad University, working with Shukul variety of mango, R. S. Bilgrami (1970) of University of Bihar, Muzaffarpur, with China and Sahi varieties of litchi, and P. S. Bisen (1972) of University of Jabalpur, with Edward and Keshari varieties of apple showed hundred per cent loss of ascorbic acid in 10 days after infection with *Aspergillus niger*.

The loss of ascorbic acid under pathogenesis may be due to the production of suitable ascorbic acid degenerating enzymes, either by the fungus alone or by the interaction of host-pathogen complex. This degeneration could be catalyzed by many enzyme systems including polyphenol oxidases, ascorbic acid oxidases, peroxidases and cytochrome oxidases.

U. C. JHA
Department of Post-Graduate Studies
and Research in Botany
University of Jabalpur
Jabalpur

Spiders

Sir, In **How spiders catch their Prey** (*S.R.*, 19 Feb. 1977) B. L. Bradoo has given a lot of interesting information. I would like to add more. *Thalassivs spenceri*, the most interesting spider, was first discovered in Natal, and has since been found in the Persian gulf and elsewhere. It is a member of the family *Pisauidae*, has very long legs and lives close to water. It takes up its position with its two posterior legs resting on a stone ashore, and the other six are spread out upon the surface film. In this position the spider waits. Its long legs are wrapped round the fish, which is bitten and dragged ashore. The spider then eats the fish with unusual speed, leaving nothing except the backbone. It has also been seen to eat tadpoles of the toad—*Bufo cavens*, and adults of the small frog *Rhappia marmorta* (*The Biology of Spiders*—Theodore H. Savroy).

Again, the little swimmer, which scientists call *Argyroneta aquatica*, is one of the most unusual among the world's 30,000 known species of spiders. It lives almost its entire life beneath the surface of water, building air-filled domicles to dine, sleep and even hatch its young. It plunges into the water depths. Instead of carrying aqua lung, it wraps a glistening bubble of air around its abdomen and its breathing pores. It reaches the bottom and when its eight myopic eyes sight a shadowy movement it lunges to seize the quarry, an inch-long rainbow guppy fish. Injecting venom with its fangs, it kills the fish, and then seems to waltz in triumph with it across the aquarium floor. Later, it devours it at leisure in its submerged home (*National Geographic*, May 1972, p. 694.)

S. THIAGARAJAN
Assistant Professor of Zoology
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Tamil Nadu 5613005

Alternative to sex ?

Sir, Thanks for the article **Alternative to sex** by N. S Rangaswamy and Akhilesh Shrotria (*S.R.*, September 1976). The article is extremely informative to biology students and also useful to botanists, agriculturists, horticulturists and plant breeders. I request you to publish an article on androgenesis in plants. The androgenetic plants of rice, tobacco and potato which have already been raised in the test-tubes by botanists of Japan and India should also be described

S N. Dey
Machkhowa, Gauhati-781009
Assam

Rosalind Franklin

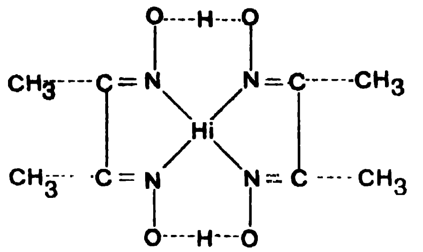
Sir, Sneh Prabha Mehta's article entitled **The woman behind the DNA scene Rosalind Franklin** (*S R.*, September 1976) has been well written Last year a book entitled *Rosalind Franklin and DNA* was published (Norton, New York, $8 95). The authoress A Sayre, who was a close friend of Franklin, spent three years in researching Franklin's contribution in the elucidation of the structure of DNA Sayre believes that, had Franklin lived, she would have been awarded the Nobel Prize in recognition of her contribution to the unlocking of molecular mystery of the genetic material

R. K. Datta
Beth Israel Medical Center
New York, N. Y. 10003, U.S.A.

Hydrogen bond

Sir, Regarding **Hydrogen bond** (*S.R.*, Sept 1976) I would like to know the following.

1. In almost all H-bonds the proton is not equidistant from the two atoms linked to it, but is nearer to the atom with which it is covalently linked. But, in very few cases like the familiar $Ni(DMG)_2$ complex the H-bonded proton is equidistant from the two oxygen atoms



In fact, it is difficult to say which oxygen is H-bonded and which one is covalently linked. Is there any reason for this ?

2. Increase in the electronegativity of an atom enhances its capacity to form H-bond Is this 'capacity' in any way related to H-bond strength? If so, why O—H......N hydrogen bond is stronger than O - H.........O hydrogen bond ? Though both chlorine and nitrogen have the same electronegativity values, the former is less effective in forming H-bonds Why ?

3 Why are 'intramolecular' H-bonds weaker than 'intermolecular' H-bonds ?

Kalipada Das
5 *South Park, Jadavpur*
Calcutta-700032

On the basis of pure electrostatic interaction, one may conclude that increasing the electronegativity of an atom increases its power of forming hydrogen bonds The tendency for atoms to take part in hydrogen bond formation decreases in the order F, O, N, Cl and S. Though chlorine has the same electronegativity as nitrogen, it has only a very small H-bondforming power; this is attributed to its bulkiness which causes its coulombic interaction to be weaker than those of nitrogen. H-bonding interactions depend on the external conditions imposed upon them by the molecules involved and by the surrounding molecules. The resultant electron distribution in a molecule may polarize the proton donor group to produce a hydrogen bond. For example, the C - H bond, in general, is not sufficiently polarized to produce a hydrogen bond. But in HCN and $HCCl_3$, where the electron distributions in the molecules are such as to make carbon quite electronegative. Moreover in H-bonding, in addition to the major electrostatic interaction, delocalization, dispersion and repulsive interactions also play an appreciable role. The strength of an H-bond in A—H......B is determined by all these factors.

The two heavy atoms A and B have a tendency to shorten their mutual distance down to a minimum when free to do so. That is why the proton in FHF-ions and in nickel dimethyl glyoxime complexes is at the centre of the bond. These are called symmetrical hydrogen bonds. In such bonds, potential energy curves have only a single minimum, since the hydrogen bond is characterised by a deep minimum in the potential energy of the proton belonging to atom A and a high potential barrier.

In chelation, intra-molecular H-bonding inhibits the free rotation of the donor group. Even then, H-bond strength in chelation is very weak on account of the long H...B distance. Also it is theoretically established that the most stable configuration is the one with A—H bond along the lone pair direction. It indicates that the non-linear H-bonds in chelation must be weaker than that of inter molecular H-bonds.

M. Meyyappan
Assistant Professor of Physics
Government College (Men)
Kumbakonam (T.N)

Quiz

Sir, *S.R.* is of special interest and importance to all science students, particularly to younger students.

University examination questions at present, specially on science subjects, are of 'quiz' type rather than the traditional broad questions. Besides university examinations in most competitive examinations science students have to face 'quiz' questions. Quiz questions are very interesting and they often offer better understanding.

My suggestion is that if you open a small, new section in *S. R.* on 'quiz' questions from experts in various science subjects, it will be of much interest to students as well as to others. Of course, space might be a problem and in that case I suggest 'quiz' can replace crossword puzzle in alternate issues.

KALIPADA DAS
6, South Park, Jadavpur
Calcutta-700032

Earwig

Sir, My thanks to Kumar Rajendra Singh for his article "Earwig" (*S.R. Nov.* 1976). The article is very interesting, but I would like to make a few comments.

Earwig (*Forficula anricularia*) should not be called a 'pest', because according to a recent concept, pests are those organisms which cause economic loss. We know that earwigs feed on dead and decaying animals and vegetables. Some have reported damage to crop plants, but the damage is below threshold injury level. So it is not a pest.

The name 'earwig' is due to semicircular ear-shaped hindwing.

Z. R. KHAN
Indian Agricultural Research Institute
New Delhi-110012

Chelating agents

Sir, I read the article **Chelating agents** by V. V. R. Sastry (*S.R.*, Oct. 1976). The article is concise and informative. It gives encouragement for the industrialists to start manufacturing various chelating agents for different applications. I hope CSIR laboratories have much to contribute for the production of cheap varieties of chelating agents in the country.

N. GOVINDA REDDY
Puspa Nivas, Rehabari
Gauhati-781008

Birds and ants

Sir, I would like to add the following to the **Science oddities** by Indira Rajagopal (*S.R.*, November 1976). Many song birds perform "anting" every two or three days, taking several minutes. Usually a bird picks up ants in beak and uses as a kind of spray can. The ant is capable of spraying the acid from its poison glands upto 20 cm. As this is a quick procedure, it has not been possible to study how the bird performs this toilet act. It has been beautifully filmed by Dr. Anke Querengasser of West Germany. The spray of acid appears to be most pleasurable to the birds and gives them a tingling sensation. During spraying, the bird closes its eyes to prevent the acid getting in and searing its cornea. When spraying is over the bird flings the ant away or gobbles it up.

Young starlings begin using ants as spray cans at the age of about five to six weeks. They tend to be timid about it at first and continue the procedure for a few seconds only. But by two months of age they are capable of using several ants at one time. By the time they are eighty days old they can spray themselves with twenty ants at a time. When the unfortunate insects are dead they are replaced by twenty new ones. This procedure may last upto twenty minutes. Some ornithologists are of the opinion that this behaviour is an instinct, but observations of ethologists do not confirm this conclusion. Young birds kept in captivity pick up variety of objects such as cigarette bits, mothballs, beetles and worms. When they realise that those objects could not provide the desired formic acid they throw them away and are not fooled again. Once a bird has a successful "fix" of formic acid it becomes "hooked" and is likely to try the trick again two or three days later.

Ornithologists are at present baffled by what the birds get out of this strange toilet act. One beneficial effect is to kill off irritating ticks in the wings and tail feathers. Yet the rump feathers, where most ticks are to be found, are never given the formic acid treatment. So, the real purpose must be something entirely different. One theory is that the formic acid is a medicinal preventive treatment to protect the birds from rheumatism to which their wing joints are particularly susceptible in cold weather. The use of formic acid in the treatment of rheumatics in human beings has long been known.

G. M. NATARAJAN
Deptt. of Zoology
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Thanjavur (Tamil Nadu)

Filariasis—its cause and control

Sir, I read the article **Filariasis —its cause and control** by Dr. Samar Chakrabarti (*S.R.*, December 1976) with much interest. The article was informative, written in an easily understandable manner and contained recent findings. Please publish more articles on other human parasites for the benefit of medical students.

SUBHABRATA ROY
Calcutta Medical College
Calcutta

Divisibility rule and remainder

Sir, K. R. Rajagopalan in his letter on "Divisibility rule" (*S.R.*, April 1977) has stated that "the divisibility rule by 11 will not admit of a method to find the remainder." The method for finding the remainder, in case the number is divided by 11 without actually dividing it, has been worked out by me and is given below :

Total the alternate digits starting from unit's digit. Let this total be 'A'.

Total the other set of alternate digits. Let this total be 'B'. Let $A-B=C$.

If (i) 'C' is a single digit and positive, the remainder, in case the number is divided by 11, will be C.

(ii) 'C' is a single digit negative, the remainder will be $11+C$.

(iii) 'C' is more than one digit number. The above process is repeated giving a new set $A_1 - B_1 = C_1$. 'C_1' will, however, be a single digit number if the original number has less than 25 digits and will be the required remainder. In numbers of more than 25 digits C_1 may be two or more digited and the above process may have to be repeated.

Example :

1. 487693

   $A=3+6+8=17$

   $B=9+7+4=20$

   $A-B=C=-3$

   Since it falls under second category (single digit, negative), remainder will be $11+C=11-3=8$

2. 918290618

   $A=8+6+9+8+9=40$

   $B=1+0+2+1=4$

   $A-B=C=36$

   $A_1=6$

   $B_1=3$

   $A_1-B_1=C_1=6-3=3$ which is the remainder in case the number is divided by 11.

SURESH SAINANEE
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Suggestions

Sir, I read with great interest **Improvements in gene isolation techniques** (*S.R.*, Aug. 1976). It helped me very much in my study. Now I want to see an article on hormones and enzymes and their activities in the living body.

K. JEEVAN RAO
College of Agriculture
Warora (M.S.)

II

Sir, I thank K. K. Tandon and Pushpinder Kaur for their article **A tale of tails** and Indira Rajagopal for her very interesting articles under **Science-oddities** in Nov. and Dec. 1976 issues respectively.

I request you to publish an article on Exoskeletons. We want to know how some animals use horns for their protection.

BRAJENDRA MISHRA
17-B, Philadelphia Hostel
E.C.C. Allahabad-211003

III

Sir, I request you to publish an article on viral diseases, especially on viral encephalitis with the latest treatment for the same.

S. D. SHARMA
G.G.S. Medical College
Faridkot (Pb)-151203

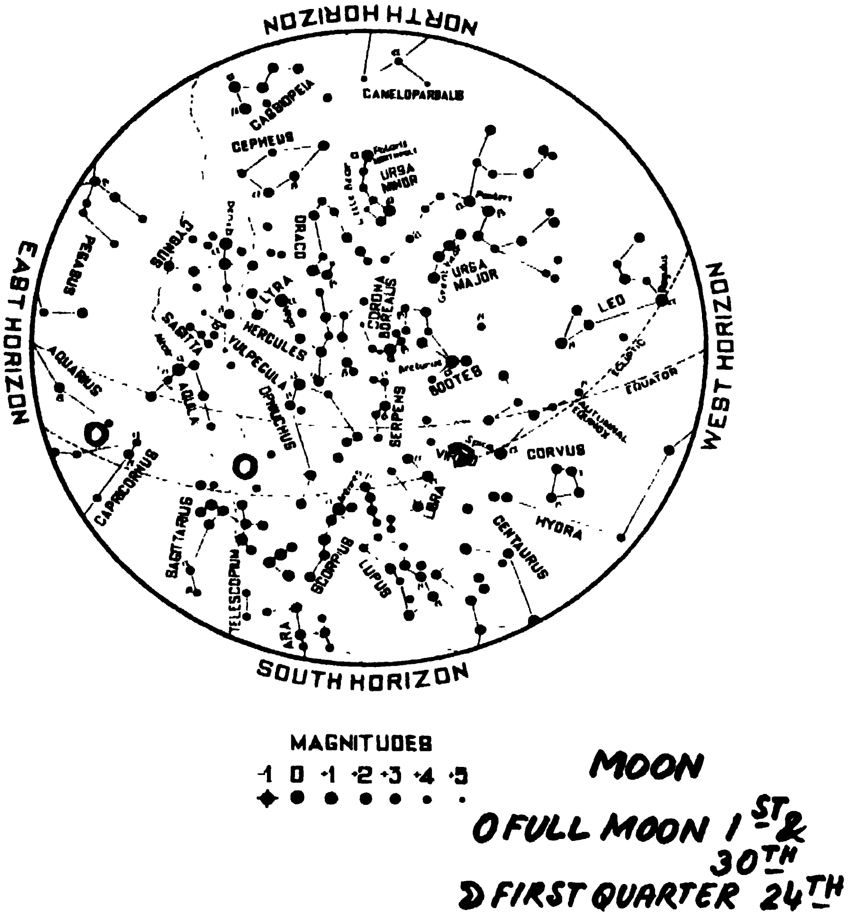
IV

Sir, I am interested in having details on blood formation and its related problems. I request you to invite articles on the subject based on the latest research work.

AJOY KUMAR PAUL
Deptt. of Zoology
University of Kalyani
Kalyani, Nadia (W.B.)

Planets and their positions

JULY 1977



The moon

FULL moon occurs on 1st at 8-54 a.m. and again on 30th at 4-22 p.m. and new moon on 16th at 2-07 p.m. I.S.T. The moon passes about two degrees south of Mars on 11th, about a degree south of Venus on 12th, four degrees south of Jupiter on 14th, about six degrees south of Mercury and five and a half degrees south of Saturn on 18th. The lunar crescent becomes first visible after the new moon day in the evening of 18th.

The moon is at apogee or farthest from the earth on 12th and at perigee or nearest to it on 28th. The earth is at aphelion or farthest from the sun on 6th.

The planets

Mercury (Budha) is too near the sun to be visible during the first quarter of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes about half a degree north of Saturn on 20th. It also passes very close to the star Regulus (*Magha*) on 28th. It moves from Gemini (*Mithuna*) to Leo (*Singha*) through Cancer (*Karkata*). Its visual magnitude varies from 1.1 to + 0.3.

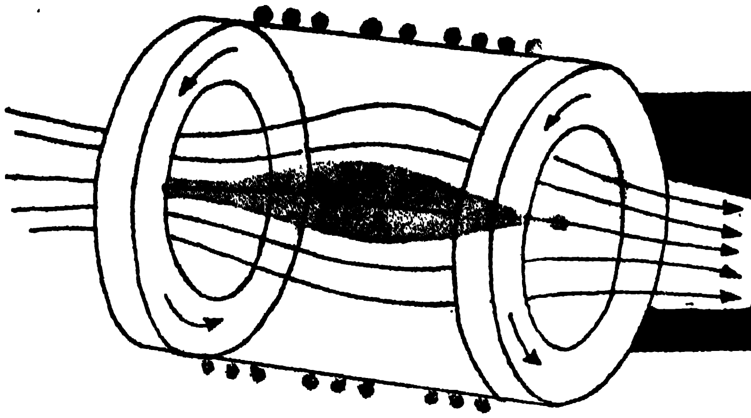
Venus (Sukra), visible in the morning sky, rises about two hours after local midnight during the month. It passes about three degrees north of the star Aldebaran (*Rohini*) in the early hours of 16th. It also passes about one and a half degrees south of Jupiter on 30th. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about – 3.7.

Mars (Mangala), a morning star, rises about an hour after local midnight during the month. It moves from Aries (*Mesha*) to Taurus (*Vrisha*). Its visual magnitude is about + 1. 2.

Jupiter (Brihaspati), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about — 1.5.

Saturn (Sani), an evening star, sets about one and a half hours after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It is in Cancer (*Karkata*). Its visual magnitude is about + 0.7.

(*Source :* Nautical Almanac Unit of the Meteorological office, P-546 Block'N', New Alipore, Calcutta-53)



QUEST for fusion power

S. P. TALWAR

Due to acute shortage of conventional fuels serious efforts are being made to exploit nuclear fusion for energy

FROM times immemorial man has been using conventional fuels like coal for meeting his daily needs. However, due to rapid industrialisation in the world, there has arisen an acute shortage of conventional fuels. The world is facing an energy crisis and a search for alternative sources of energy is afoot.

The present world consumption of energy is estimated at about 0.2 Q per year and is increasing by 3 to 5 per cent every year. A rough picture of the global energy consumption in the past is given in the Table 1 alongwith the extrapolated consumption rate during the first half of the 21st century. We note with concern that a rate of 1 Q per year is fast approaching, and, naturally, enquire if the world has enough fuel to meet the demands of future. The coal, gas and oil reserves of the world are estimated at 40 Q and are therefore likely to be completely exhausted soon. Alternative sources of power are solar energy, geothermal energy, wind power, tidal power and nuclear power. At present serious efforts are being made to exploit them for the benefit of mankind.

Nuclear fuels

During atomic and hydrogen bomb explosions, both fission and fusion forms of nuclear energy are respectively released instantaneously. However, the energy so released is uncontrolled and thus not useful. What is, therefore, needed is to 'tame' these reactions so that the energy is released at a more leisurely rate rather than in an explosive manner. The fission energy, arising due to fragmentation of heavier nuclei of uranium, thorium, etc., has since been tamed and is available in a controlled manner from various atomic reactors. However, the entire deposits of the fissionable materials in the world are roughly 10^8 tons (equivalent to 600 Q), which, if fully exploited, should serve the human needs for the next several hundred years—a rather small interval of time on the geological scale. In addition, there is the problem of radioactive waste as also the problem of quite a few 'have not' countries who will have to depend on others for the supply of the fissionable material.

Fusion material, deuterium (an isotope of hydrogen), on the other hand, is abundantly available in the form of sea water; it amounts to about 10^{14} tons (roughly equivalent to 10^{10} Q). This should then be able to supply one thousand times the present power consumption for one billion years. Other additional factors in favour of controlled fusion energy are the comparatively low cost in production; a number of

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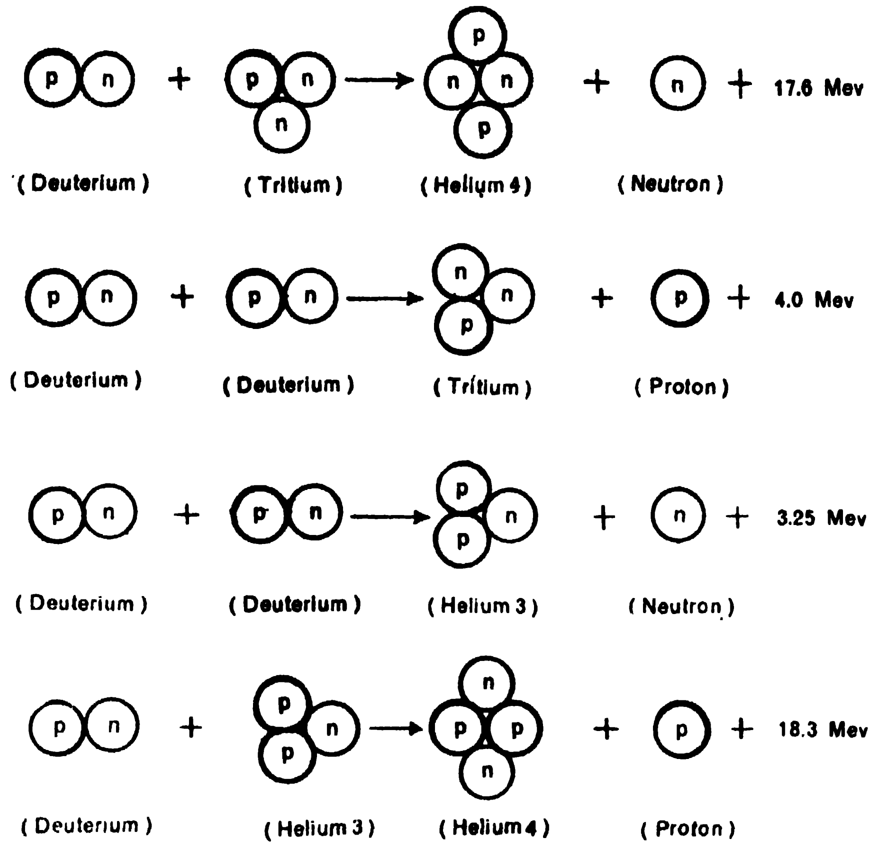

(1 Mev = 1.6×10^{-13} joules of energy)

Fig. 1. Fusion reactions

'have not' countries, the distribution of water reasonably uniform the world over; and essentially negligible radiation problems. Unfortunately, fusion energy is not yet possible to obtain in a controlled manner. If it were possible in some way to accomplish a fusion reactor, this surely would have solved the energy problem for almost all time to come.

Fusion reactions

To answer the question as to why it has not been possible so far to obtain controlled fusion, we need to understand the process of fusion of two nuclei. It is clear that the fusion of two deuterium nuclei is possible only if they can approach very close to each other (less than about 10^{-12} cm), when they can feel the strong short range nuclear forces. This, however, cannot happen unless the charged nuclei strike against each other so hard as to overcome their mutual repulsive Coulomb force arising due to the positive charge of the nuclei.

Fusion reactions take place in the interior of stars and are now believed to be responsible for the energy release from stars. In stars, light nuclei fuse together to form heavier nuclei, releasing a corresponding energy for the loss of mass during the process. The energy so released is given by Einstein's famous mass-energy equivalence relation, $E=mc^2$ (where m=mass loss and c=velocity of light). So in most stars hydrogen forms the 'fuel' and helium the 'ash'. Fusion reactions take place in stars on account of their extremely high temperatures. It is thus clear that an essential prerequisite for realising fusion reactions on earth is to produce extremely high temperatures, of the order of several million degrees, as are found in the interior of stars. Fusion reactions in stars are, however, rather too slow to be useful on earth though they yield energy at a high rate on account of the large stellar masses. Laboratory fusion reactions must, therefore, involve nuclei which interact more readily like deuterium and tritium (the two isotopes of hydrogen) (Fig. 1)

The magnetic bottle

The problem of generating extremely high temperatures in laboratory is essentially similar to that faced by the alchemists, who, apart from being interested in making gold from the base metals, wanted to evolve a universal solvent which could dissolve all material substances. However, before they could think of such a substance, they had to bother about a bottle to contain that, because otherwise the bottle itself would be dissolved ! Surely, what bottle could hold a fluid that would dissolve everything ? The situation with regard to ultra-high temperatures is similar, though not that hopeless. How do we contain such hot stuff, having million degrees temperature, even if it were somehow available. The physicists have, however, found an answer. They have been able to evolve what is known as a 'magnetic bottle' in which an ionized gas

Fig. 2. The linear pinch

(plasma) can be confined at least in principle. The plasma could be kept off the walls of the container if a high current of several thousand amperes is made to flow through the gas. This self-constriction in the gas due to the passage of a high current, known as the 'Pinch Effect' is not difficult to understand physically.

We know that two wires carrying electric current in the same direction attract each other and the current flowing in the gas could be regarded as being made up of a large number of such wires carrying parallel currents. In principle the pinch effect looks docile but in practice causes headaches. It is true that a 'magnetic bottle' is possible, but the difficulty is that the plasma, being kept off the walls, becomes violently unstable (Fig. 2). It wriggles back to the walls within a few microseconds, so that the nuclear reactions are not possible. The 'magnetic bottle' thus turns out to be 'leaky'.

A quantity of interest in thermonuclear work is the Lawson parameter given by the product NT of the number of particles per c.c. N in the plasma and the time of stable confinement T. For net output of energy the value of this parameter should exceed 10^{14} cm^{-3} sec. With number density (N) in the range 10^{13}-10^{17} per c.c., the time of stable confinemet (T) should thus lie in the range of 10-10^{-3} sec. A major part of the present research in controlled fusion is devoted to finding ways and means for extending the confinement time to a reasonable fraction of a second so that thermonuclear reactions could take place.

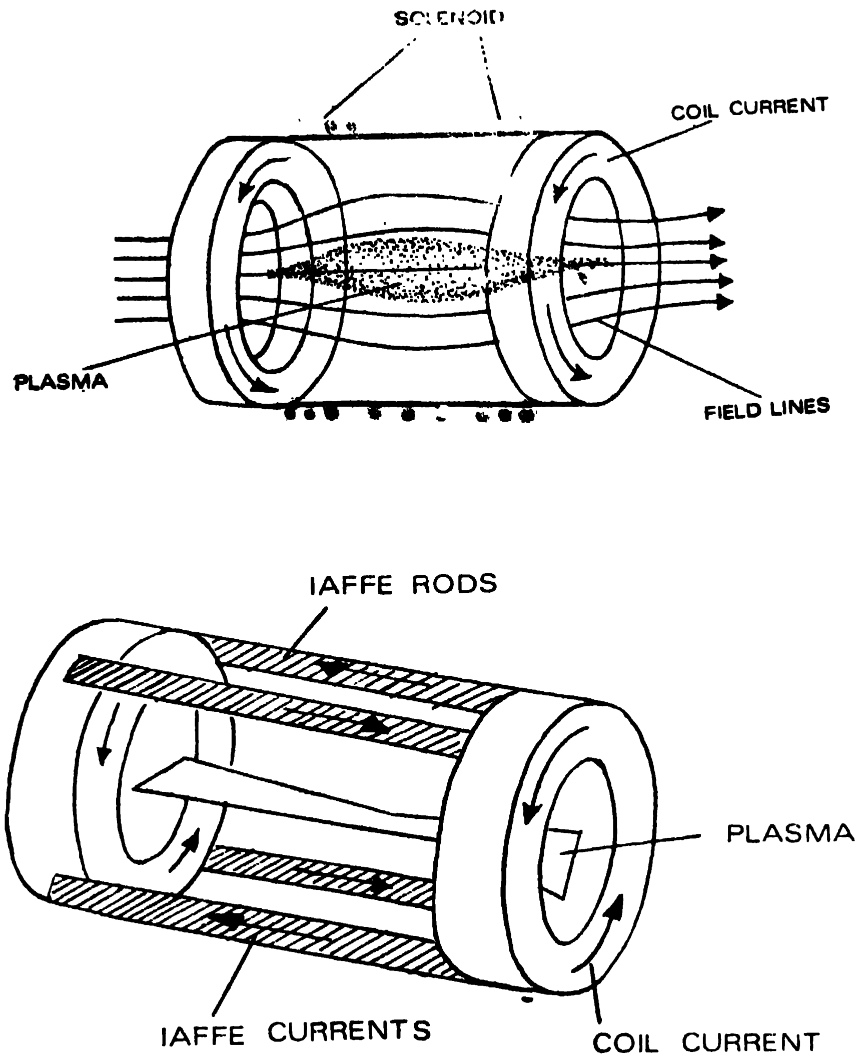

Fig. 3. Mirror (*top*) and Ioffee (*bottom*) geometry

The promising CTR devices

Several controlled thermonuclear (CTR) devices have been suggested and tried since 1958 when the secrecy restrictions on fusion work were removed. Many of them have since been rejected as futile attempts while some others are still regarded as promising ; for example, the minimum B-geometry and the Tokamak. All these devices make use of magnetic fields as a confining agency for the charged particles (electrons and ions) constituting a plasma. They are based on a well-known fact that a charged particle gyrates around the lines of force.

The minimum B-geometry is based upon the magnetic mirror concept. In it a longitudinal magnetic field is applied externally to the

"First he worked on fission which led him to a split personality. On my suggestion, he is now working on fusion to regain his unified personality"

plasma using a solenoid which is closely wound near to the ends of a straight tube. In this manner the magnetic field is increased in these regions and so form magnetic mirrors at the ends (Fig. 3a). Under suitable conditions, the charged particles moving towards the mirrors are reflected back towards the interior of plasma and are thus confined. However, the simple mirror system cannot hold back all the particles ; in particular, the particles moving along the axis (parallel to the lines of force) are not at all impeded and so leak out of the system. Also the geometry is unstable, as the magnitude of the magnetic field, though incraeases towards the ends, decreases radially.

Evidentally, this instability can be suppressed if another suitable magnetic field is superimposed on the mirror field so that the resultant magnetic field increases in all directions away from the centre of the system (Fig. 3b). Such a method was originally suggested by M.S. Ioffe of Kurchatov Institute, U.S.S.R.; and the geometry is named after him, called Ioffe geometry. In western literaure it is usually designated as the minimum B-geometry. It consists of four conducting rods carrying current placed parallel to the axis of the systemn. The currents in the alternate conductors are in opposite direction so that they produce opposed magnetic fields, which cancel each other at the axis and hence do not add to the field created there by the end coils. There is no cancellation, however, near the rods in the outer areas where the fields created by the rods and the coils add up. Thus the magnetic field is weakest at the centre and bcomes stronger towards the walls, so that the particles are reflected inward, no matter where they seek to escape.

"My thesis is on: "Diffusion of confusion over fission and fusion"

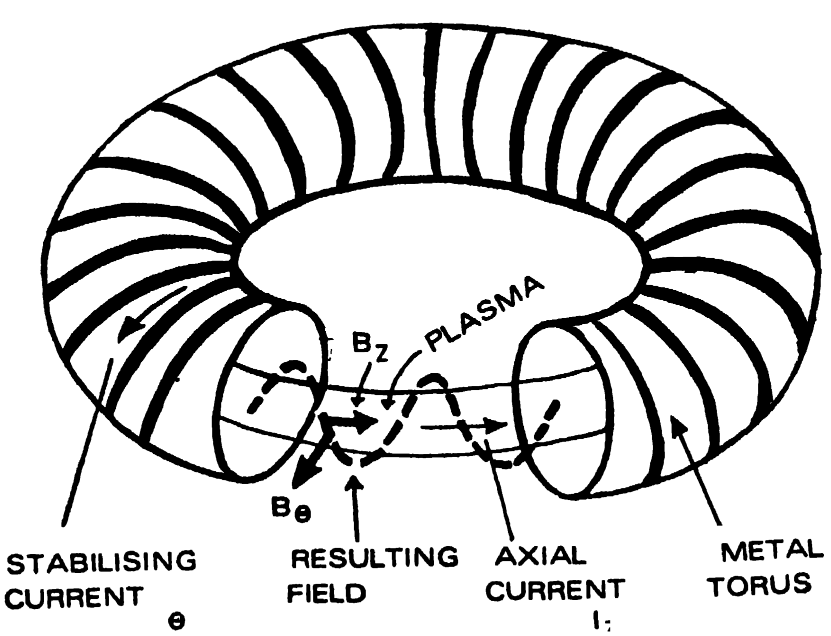

Fig. 4. Tokamak geometry

Tokamak is perhaps the most promising CTR device which uses magnetic confinement. It is a toroidal (endless) system in the form of a doughnut (Fig. 4). In the open CTR devices like the mirror, the confinement time is limited as the charged particles leak through the system along the lines of force. These end leaks are naturally absent in endless systems and the only way the plasma can escape from this trap is by crossing the lines of force. This crossing is carried out either by diffusion process or an interchange instability in which the plasma and the magnetic field change places. This expulsion of the plasma can, however, be minimised by using helical magnetic fields as in a Tokamak. Tokamak also originated in the U.S.S.R., though at present several laboratories in the world are working on improved versions of this geometry.

The special features of Tokamak are: a doughnut shaped vacuum chamber, a toroidally wound solenoid carrying current (I_θ) which provides a strong magnetic field (B_z) around the torus, and a transformer threading the torus such that the plasma ring inside it acts as the secondary. A plasma current (I_z) is induced around the torus on energising the transformer. This current does a two-fold job: it heats the plasma by Ohmic dissipation while simultaneously provides the confinement of the plasma column through the force arising due to interaction with its self magnetic field (B_z). The strong toroidal magnetic field (B_z) parallel to the current (I_z) helps in preventing the instability of the plasma column.

Table 1

World energy consumption

Time	*Energy consumed*
Upto 1850	<10Q
1850—1950	4Q
1950—2000	15Q
2000—2050	100Q

World energy reserves

Fuel	*Energy potential*
Conventional fuels gas.oil and coal	40 Q
Fission fuels	600 Q
Fusion fuels	1010Q

1Q-10^{21} joules of energy (enough to raise the temperature of 2400 Km^3 of water from 0° C to 1000° C without boiling it).

The work on the first generation of Tokamak models has produced ion temperatures of about 10 million degrees and the Lawson parameter NT as 10^{12} cm^{-3} sec. Work is currently in progress in several laboratories in the world on the second generation of Tokamaks; T-10 model in the U.S.S.R., PLT model at Princeton, U.S.A. and Divertor model at Culham, England. The reason for the optimism shown towards the Tokamak is that higher temperatures and longer confinement times can be achieved simply by increasing the discharge current. For example, in the T-10 model, field strengths of 100 kilogauss are planned to be used along with a million amperes discharge current, producing thereby temperatures about 20 times larger and the confinement time about 50 times larger than the presently attained values. The dimensions of such a model might be as high as 2 metres for the plasma diameter and 10 metres for the torus diameter. It may be mentioned that the Tokamak model is a formidable engineering challenge; for instance, a 10 T magnetic field would produce an enormous pressure nearly 41400 kilonewton per metre^2 on the coils, necessitating the use of superconducting magnets.

In the last few years, a major turn to the controlled thermonuclear program has been brought about by the suggestion that powerful lasers may be used instead of magnetic fields to realise fusion. Intense laser radiation is focussed isotropically from several directions on a small pellet of solid deuterium-tritium fuel, so that it is immediately converted into a dense gaseous plasma of density in the range of 10^{19}-10^{22} particles per c.c. With this high density the thermonuclear reactions may be sustained without any external confinement. However, at the moment the greatest hurdle in laser fusion is the non-availability of highly energetic lasers, which should ensure that the energy output is larger than the total energy input.

Conclusion

Both laser fusion and the magnetic confinement work are being actively pursued in several major laboratories in the world. In our country, however, experimental thermonuclear program has yet to make a start, although theoretical work in this area has been actively pursued for the past several years at some universities and research centres.

No doubt at present there appears to be a tinge of alchemical tradition to the possibility of a controlled fusion reactor, but ultimately the sustained efforts of the plasma physicists and the engineers will bear fruit. None of the proposed devices has yet been crowned with success and it is difficult to say, which approach, if any, is likely to be the first to meet with success. It may however take the next ten or twenty years to realize a thermonuclear reactor, but the importance of the problem in itself justifies a major effort. One hopes that a thermonuclear reactor would be available for the benefit of mankind by the beginning of the next century.

CORRIGENDA

1. Ref. Article "Organotin chemicals in industry". SR May, 1977 p. 290, col. 2, line 3 *for* R_3 SnX_2, $R_2 SnX_3$ *read* R_3SnX, R_2SnX_2 and col. 3. line 11 *for* o cyte *read* octyl. p. 293, col. 1, line 16 *for* 0.5% =2% *read* 0.5% - 2%
2. Ref. (*i*) Article "Sodium — the uncommon metal from common salt." SR April, 1977, p. 233 col.1, line 1. *for* thermal conductivity at 20°C *read* thermal conductivity at 200°C

(*ii*) Article "History of particle physics". p. 219, para 4, line 11 *for* to modifications *read* no modificatios; p. 220, col. 2 line 21 *for* mestron *read* mesotron

(iii) Article "IMS — a potent mutagenic agent" SR April 1977, p.248, para 1 line 3 and 4 *for* Stadler working on common shrub (Datura), *read* working on barley (*Hordeum vulgare*); p. 244 col. 2 para 1, line 25 for (X-or α-rays) *read* (X-rays or γ-rays).

BINARY SYSTEM

THE BASIS OF CALCULATING MACHINES

Binary system is an important device for transformation and transmission of information process

BHARATI BANERJEE

ONE of the most fascinating features of the present rapid technology is the 'information processing' system—the technology based on the transformation and transmission of information. With the development of new technologies, the mathematicians became more aware of the importance of the binary system, which is an essential factor for digital computers. It is one of the most important devices for transformation and transmission of information process.

The computer is like a human brain but works million times faster for solving problems. The binary system is not only useful for computer but is also an important tool for elementary advanced mathematics.

Binary system is nothing new, only its importance has increased tremendously in recent years. The system was known in ancient China. The Britishers used the binary system in their weighing units of pounds with the help of 1 lb., 2 lb., 4 lb., 8 lb. and 16 lb.; maximum weight of 31 lbs. could be weighed.

The pure mathematicians were also fascinated with two and powers of two. There are several instances of fascinating nature of two. For example, consider Pascal's Triangle. (Table 1)

We find a distinct relationship between the total and the number of lines. If there are 7 numbers of lines, the total would be 2^7 if there are n numbers of lines, the total would be 2^n.

We are also familiar with surprising growth of 2 under the process of doubling it. If we put a grain of wheat on the first square of a chess board, 2 grains on the 2nd square, 4 grains on the 3rd square and so on, the last square will need 2^{64-1} number of grains, which is equal to 18, 446, 744, 073, 709, 551, 616.

Binary system

The binary system deals with two number symbols 0 and 1. The number system we are using in our every day life is known as 'denary' or decimal system. In this system we are using ten basic number symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Probably ten fingers in a man's hands is the cause of adopting ten number symbol. The system was invented by Hindus, and Arabs spread it over the Western countries. This system is concise and economic. We can express any number however small or large it may be with the help of only these ten basic number symbols. The symbol "Zero" invented by Hindus

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plays the key role in this system.

If we understand the nature of decimal system, it will be easier for us to have a proper concept about the binary system. In decimal system, we use ten basic symbols, in binary only two symbols, in octal we use the eight basic symbols 0, 1, 2, 3, 4, 5, 6, 7.

In decimal system we arrange the numbers in 'groups of tens' and consequently in 'powers of tens'. If we have 9 marbles, we can count from 1 to 9 and represent it with these numbers from 1 to 9. If we have ten marbles, then to represent this we use the idea of one group of ten and write as 10.

Look at the figure 1 representing the number of persons in a group.

If we group these persons in tens, we find there are 3 groups of tens and 2 groups of one. So we write 32, which means 3×10+2×1. Look at the array of dots in Fig. 2.

In Fig. 2 we have arranged the dots in groups of tens. There are ten groups of ten (representing one group of hundred), one group of ten and 4 groups of units. In all they represent 114. We can arrange them in columns as shown in Fig. 3 (next page).

Since 'ten' is the basis of grouping in 'denary' system, we can have columns arranged in powers of tens. (see Table 2 next page)

Hence, with this notation Fig 3 becomes Table 3 (next page)

Consider now the Table 6. From this table, it is clear that the number from 0 to 9 are placed in units column. For ten, we are writing 1 in the column of ten and '0' in the column of units. This indicates only one group of ten and zero group of unity. For twenty, we mean two groups of ten. For ninety

Table 1. Pascal's triangle

Lines	Sequence	Total	Powers of two
0	1	1	2^0
1	1 1	2	2^1
2	1 2 1	4	2^2
3	1 3 3 1	8	2^3
4	1 4 6 4 1	16	2^4
5	1 5 10 10 5 1	32	2^5

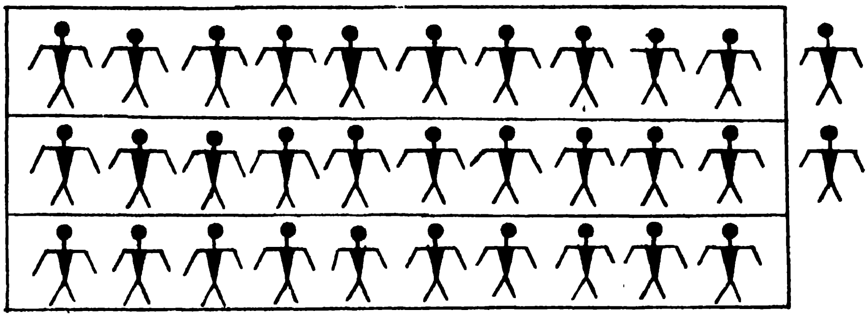


Fig 1. 3 groups of ten + 2 groups of one

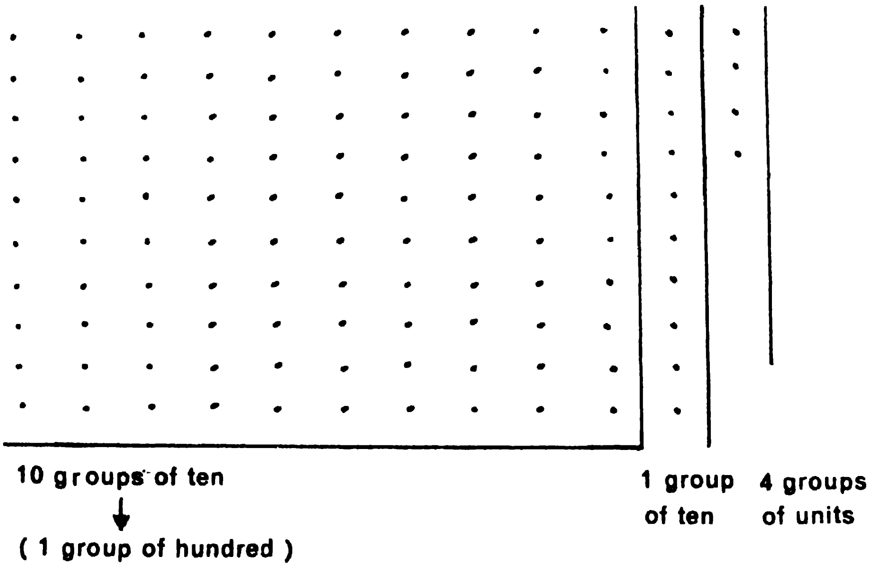


Fig. 2

Table 2

Ten to the power zero = 10^0 $=1$
Ten to the power one = 10^1 $=10$
Ten to the power two = $10^2=10 \times 10$ $=100$
Ten to the power three $=10^3=10 \times 10 \times 10$ $=1000$
and so on.

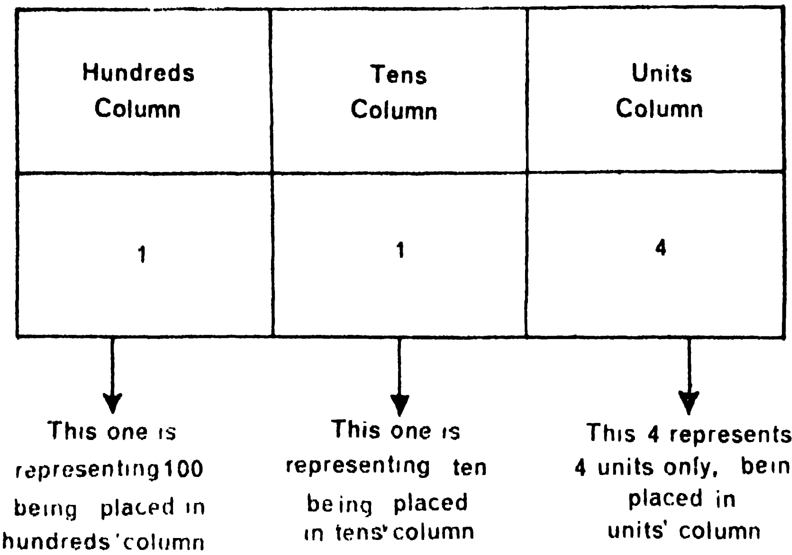

Hundreds Column
Tens Column
Units Column
1
1
4
This one is representing 100 being placed in hundreds' column
This one is representing ten being placed in tens' column
This 4 represents 4 units only, being placed in units' column

Fig. 3

Table 3

10^2 1000	10^1 10	10^0 1
1	1	4

nine, we are writing 9 in the column of ten and 9 in the column of units indicating nine groups of ten and nine groups of unity.

In the expanded notation, this can be expressed as

$$9 \times 10^1 + 9 \times 10^0 = 9 \times 10 + 9 \times 1$$
$$= 90 + 9$$
$$= 99$$

Hence the numbers from 10 to 99 are expressed by the two columns of ten and units respectively. Hundred means one group of hundred, zero group of 10 and zero group of units. 1 written in place of 10^2, 0 in place of 10^1, and 0 in place of 10^0 mean 100. The number 223 can be written in the expanded form as

$$2 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$
$$= 2 \times 100 + 2 \times 10 + 3 \times 1$$
$$= 200 + 20 + 3$$
$$= 223$$

It is clear now, how zero plays a key role in decimal or denary system and how we are utilizing the place value system. In the number 223, 2 being placed in hundreds' column represents 200, 2 in tens' column represents 20 and 3 in unit's column represents 3 units only.

From the above examples, it is apparent that we can continue increasing number of columns having consecutive powers of ten in increasing order and as such we can express any number however large it may be. Hence the basic features of denary system are: (a) arrangements of numbers in groups and powers of ten; (b) the use of ten symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9; and (c) the use of zero.

This system is useful in expressing decimal fraction also.

Consider the following :

Ten to the powers minus one
$= 10^{-1} = \frac{1}{10} = .1$
Ten to the powers minus two
$= 10^{-2} = \frac{1}{100} = .01$
Ten to the powers minus three
$= 10^{-3} = \frac{1}{1000} = .001$

To express the number 1.2 see Table 4.

Consider the decimal fraction 2.39

In the expanded notation, 2.39 can be expressed as in Table 5.

It appears that to express the decimal fraction, we have to arrange column from left to right in decreasing powers of ten starting with 10^{-1}. (see Table 7)

Table 5

$2.39 = 2 \times \quad + (3 \times 1/10) + (9 \times 1/100)$
$= 2 + 3/10 + 9/100$
$= 2 + 30/100 + 9/100$
$= 2 + 39/100$ (Two and thirty nine hundredths)

Table 4

Number	Units place	One tenth place
1.2	1	2

Table 6

Ten thousands $10.^4$	One thousands 10^3	Hundred 10^2	Tens 10^1	Units $10^0$1	Numbers
				0	Zero
				1	One
				• • • 9	→ Nine
			1	0	→ Ten
			: • 1	• • • 5	→ Fifteen
			• • 2	• • • 0	→ Twenty
			• • • 9	• • • 9	→ Ninety nine
		1	0	0	→ Hundred
		2	2	3	→ Two hundred and twenty three
	1	: • 0	: • 0	: • 0	→ One thousand

Table 7

Number	Thousands 10^3	Hundreds 10^2	Tens 10^1	Units 10^0	Tenth 10^{-1}	Hundredth 10^{-2}	Thousandth 10^{-3}
1.23				1	2	3	
15.541			1	5	5	4	1
114.3		1	1	4	3		

Keeping the above system in view, we would like to express numbers in binary system. In binary system we arrange the number in groups of two and powers of two. The basic number symbols are 0 and 1.

We have to express all the numbers however large or small it may be with the help of two symbols 0 and 1 only. Thus in binary system one is 1; two is one group of two and written as 10; 2 is 11 (one group of 2 and one unit); four is 100 (one group of 2, zero group of 2 and zero group of units) and so on. Consider the Table 8.

Consider the array of dots as shown in Table 9 (next page. Therefore, the number of dots in the array expressed in binary system is (11 11) two.

To differentiate binary numbers from denary numbers, we use a suffix of 2 with binary number. So the above number in binary system would be (11 11) two.

Now let us compare the number in binary and denary system by doubling the member.

Denary	0	1	2	4	8	16
Binary	0	1	10	100	1,000	1,0000

We find that when we are doubling the denary number we are adding one zero to the corresponding binary number. If we arrange the number in different columns, denoted by the different powers of 2 to indicate different place, we find multiplying by two means shifting one place to the right. This property is useful in calculating machines and so multiplication becomes as easy as addition.

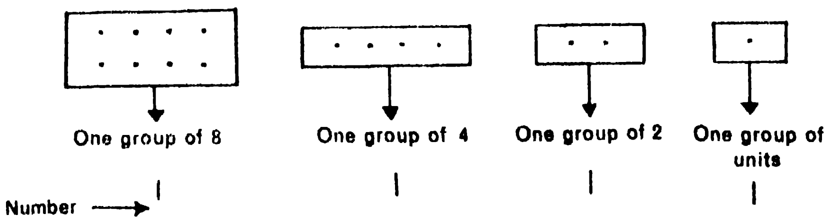
Conversion of denary number to a binary number

Since in binary system arrangements are made in groups and powers

Table 8

Denary			Binary				
Numbers	Tens	Units	16's $=2^4$	8's $=2^3$	4's $=2^2$	2's $=2^1$	Units $=2^0$
Zero		0					0
One		1					1
Two		2				1	0
Three		3				1	1
Four		4			1	0	0
Five		5			1	0	1
Six		6			1	1	0
Seven		7			1	1	1
Eight		8		1	0	0	0
and so on							

Table 9



of two, we divide a denary number by 2 and continue the process until the remainder is zero.

· Consider the denary number 25 expressed as $(25)_{10}$

We first divide 25 by 2 to find how many groups of two are there and how many units are left.

Division 2/25 Remainder 1
12
Quotient

We find that there are 12 groups of two and one unit. So the digit in the unit's place will be 1. Now all twelves cannot be expressed in the two's column, we divide 12 by 2 again and see how many groups of four (2×2) there are and what will be the remainder

Division 2/12 Reminder 0
6
Quotient

We see that there are 6 of (2×2) grouping and the reminder is 0. We place the reminder 0 in two's column. We continue dividing in this manner, since we cannot record 6 of the (2×2) grouping in the 4's column. Consider now Table 10. What we get in that is being represented in Table. 11.

Table 10

2 | 3 —Reminder 0, this will be placed in 4's column
2 | 1 —Reminder 1, this will be placed in 8's column
0 —Reminders 1, this will be placed in 16's column

Table 11

Place	16's	8's	4's	2's	1's
Number	1	1	0	0	

Hence the corresponding binary number is $(11\ 00\ 1)_2$

Consider the number $(15)_{10}$in Table 12.

Table 12

2 | 15
2 | 7 Reminder 1 units place
2 | 3 Reminder 1 two's place
2 | 1 Reminder 1 four's place
0 Reminder 1 eight's place

So the number will be $(11\ 11)_2$

Conversion of a binary number into number

Consider the binary number $(11\ 00\ 1)_2$-The number can be arranged in columns of twos as ni : Table 13

Table 13

32's 2^5	16's 2^4	8's 2^3	4's 2^2	2's 2^1	Unit 2^0
	1	1	0	0	1

In the expanded notation

$$(11\ 00\ 1)_2 = 1\times16+1\times8+0\times4+0\times2+1\times1 = 16+8+0+0+1 = (25)_{10}$$

This can be done in another way also. Multiply repeatedly by 2 beginning from the left and add in the next digit each item. (See Table. 14 next gage).

We know that in our well known denary system four fundamental operations are addition, substraction, multiplication and division. In binary system also we have four fundamental operations.

1. *Addition* : For the binary addition we have to remember that arrangements are done in group of two. We have zero, one; instead two we write $(10)_2$ as one group of 2

Hence

$0+0=0$
$0+1=1$
$1+0=1$
$1+1=(10)_2$ one group of two

This we can arrange as follows:

Operation		Column 1	Column 2
Operation	+	0	1
Row 1	0	0	1
Row 2	1	1	10

Table 14

$$\begin{array}{lllll}
1 & 1 & 1 & 0 & 1\\
1\times2=\underline{2} & & & & \\
 & 3\times2=\underline{6} & & & \\
 & & 7\times2=\underline{14} & & \\
 & & & 14\times2=\underline{28} & \\
 & & & & 29
\end{array}$$

Hence $(111\ 01)_2 = (29)_{10}$

Start with the number 0 in row 1, to be added to the number 0 in column 1. We write down the result $0+0=0$ in the intersection of row 1 by column I. If we like to add 1 in row 2 to 1 in column 2, the result is $1+1=(10)_2$ recorded in the intersection of row 2 and column 2.

Example: $(11)_2+(11)_2$
$=(10\ 10)_2$

(2) *Substraction*: Since substraction is an inverse operation of addition, we can remember the basic facts.

Subtraction
$0-0=0$
$1-0=1$
$1-1=0$
$(10)_2-1=1$

Addition
$0+0=0$
$0+1=1$
$1+0=1$
$1+1=(10)_2$

Example :

$(101)_2 - (11)_2 = (10)_2$

Table 15

Operation		Column 1	Column 2
Operation	×	0	1
Row 1	0	0	0
Row 2	1	0	1

(3) *Multiplication* : The basic facts to be remembered for multiplication are the following :
$1\times1=1$
$1\times0=0$
$0\times0=0$
$0\times1=0$

This can be written as shown in Table 15

Consider the number 0 in row 1 to be multiplied by the number 1 in column 1. The product is 0 and recorded in the intersection grid of row 1 and column 1. If we want to multiply 1 in row 2 by 1 in column 2, the product is recorded in the intersection grid of row 2 and column 2

Example:

$$\begin{array}{r}
(110)_2\times(10)_2\\
110\\
\underline{10}\\
000\\
\underline{110\times}\\
\underline{1100}
\end{array}$$

Hence $(110)_2\times(10)_2=(1\ 100)_2$

(4) *Division* : Since division is an inverse operation of multiplication, we can perform division by remembering basic facts of multiplication and subtraction of binary numbers.

Binary system and its uses

The above discussion, in short, shows that the binary number follows all the four fundamental operations. This can be readily used in elementary mathematics as well as higher and advanced mathematics.

The binary system is now being very effectively used in computers and thereby helps in the development of various branches of mathematics.

The abacus probably is the earliest mathematical machine. Blaise Pascal, of France, in 1642 invented first calculating machine. In 1671, German mathematician and philosopher Leibnitz invented a machine which was useful for four fundamental operations, namely, addition, subtraction, multiplication and division. In England, Engineer Charles Babbage, in 1833, designed a machine named as Analytical Engine, which was more sophisticated and useful in nature. He tried to develop it further but probably the reason for lack of development was the use of denary system. Leibnitz pointed out the advantage of binary system of representing numbers but he never used the idea himself. The binary computer came into existence in 1940-50 and since then binary system is gaining ground in helping the growth of modern technology.

The electronic digital computers have two basic components : (1) Memory element, (2) Logical elements (switching elements). These elements are binary. The circuit that stores the information to solve a particular problem is known as "Memory". The recording is done on magnetic tape or on punched card or on a magnetic revolving drum. These devices are basically binary inform.

It is also useful for simple logic. In the logical choice 'yes' or 'no' the two symbols 1 and 0 can be used precisely. The machine can be adjusted for 'and', or and 'neither' decision only.

(*Continued on page 407*)

SUPERHEAVY ELEMENTS OF THE FUTURE

RABIN TARAFDAR

Recently the discovery of some super heavy elements has been claimed and existence of many new metals has been announced

IN recent years there have been claims for the discovery of super heavy elements. Recently (*Physical Review Letters*, July 1976), a group of scientists in the U.S.A. announced the existence of element No. 126 and a doubtful evidence even for elements No. 114, 116, 124, 125 and 127 in a Madagascan sample of mica on the basis of X-ray spectra. First, we should know if there is any scope to synthesise new elements; second, which positions of the Periodic Table are relatively easy to fill up and likely to be filled up in the near future (or which elements need a rigorous search in nature) and third, what the chemical properties of such elements will be.

On the earth we have only 92 elements in different isotopic forms. The remaining 11 members of the existing Periodic Table are all laboratory, made, and all of them are potentially unstable. In fact, filling up of the Periodic Table was started just after its publication by Mendeleev in the year 1869, when he left deliberately a number of gaps in it which were filled up later on. After the advent of atomic particle accelerator machines the extension of the Table started and all the elements from 93 to 103 were synthesised. In fact, some of the lower elements, namely, 43 and 61 are also synthetic elements.

When the two stable components of an atomic nucleus, proton and neutron, jointly called nucleons (neutron is semi-stable. outside the nucleus it ultimately decays to proton and electron with half life period of about 12 minutes), come closer to a distance of about 10^{-13}cm., they exhibit a very strong, attractive force called nuclear attractive force. The nature of this force is still not completely known, but it is the strongest of all the known forces like gravitational and electromagnetic forces.

These forces of attraction within the nucleus operate between any two nucleons irrespective of their charges, i.e., between proton and neutron, neutron and neutron, proton and proton. But in the last case, in addition to the attractive force, the coulombic repulsive force between the similar charges does exist. The distance-dependent nature of these two forces, nuclear attractive force

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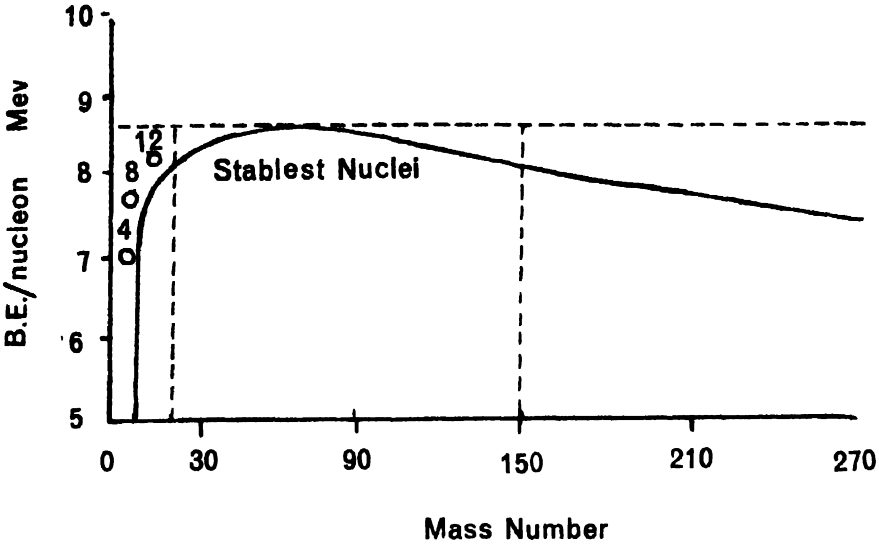


Fig. 1

and coulombic repulsive force, between the protons is different. The latter is inversely proportional to the square of the distance but the former varies still more rapidly. Consequently, when distance between two protons is about 10^{-13} cm, the two forces are nearly the same. But at still smaller distances nuclear force becomes much stronger than repulsive force. At greater distances, the coulombic repulsive force becomes more stronger.

Consequent upon this short-range nature of nuclear force each nucleon will interact strongly only with its nearest neighbours, say 8 to 12 nucleons. But the coulombic repulsive force between the protons is long-range type. So each proton will repel every other proton in the nucleus and tends to break down the nucleus. That is why starting from the nucleus of hydrogen atom, as the number of proton and neutron increases, stability of the resulting nuclei at first increases, but after a certain mass number stability decreases with the further addition of nucleons. This decreasing stability restricts the number of elements in nature. Thus, when one more proton is added to a nucleus of $_{82}Pb^{208}$ which has 82 protons, it experiences attractive nuclear-interaction from only a limited number of nucleons due to short-range nature of the nuclear force. However, it repels each of the 82 existing protons. Therefore, addition of protons in heavy nuclei increases the destabilising force more rapidly than the stabilising force. If we plot the stability per added nucleon against the mass number, we get a curve (Fig. 1) popularly known as binding energy curve per nucleon. The stablest nuclei have mass numbers from 20 to 120.

To understand the interaction of the nucleons in the nucleus, Danish Scientists, Niels Bohr and J.A. Wheeler, developed in 1939 the "Liquid Drop Model" for nucleus. The central idea of this model is that the nucleons in the nucleus are held together by the nuclear force and assume a spherical shape (like small drops of liquids of high surface tension). When the shape is spherical, the surface area is minimum and a minimum number of nucleons

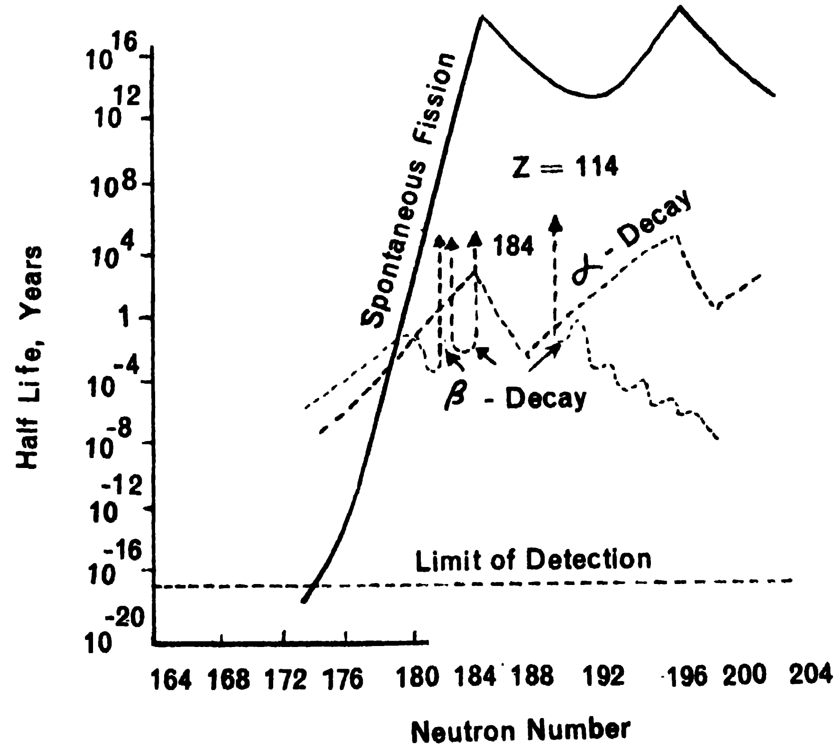


Fig. 2

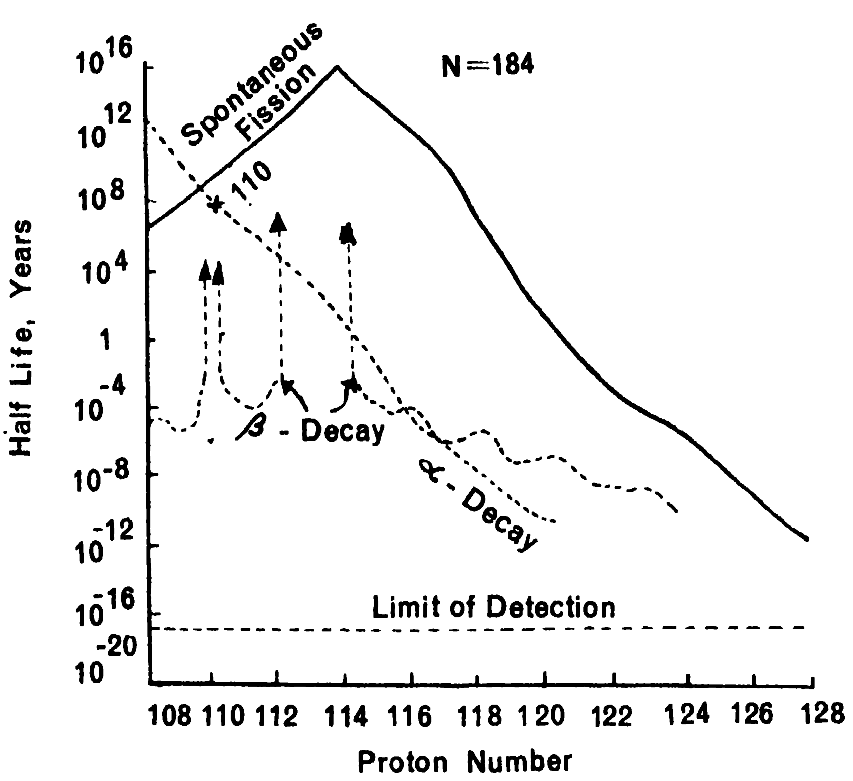


Fig. 3

will be on the surface and a maximum inside the drop. Consequently maximum number of nucleons will undergo nuclear interaction. The repulsion between the protons will, however, tend to deform the nucleus from its spherical shape to ellipsoidal. As the number of protons increases the destabilising action increases more rapidly than the stabilizing action and the shape changes from spherical to ellipsoidal.

This model could explain easy fission of the heavy nuclei and fusion of the lighter nuclei, but it failed to explain the special stability of certain nuclei such as $_6C^{12}$, $_8O^{16}$, etc., compared to their nearby nuclei. Special stability of certain nuclei suggests that nature gives preference to certain grouping of the nucleons just as certain grouping of the electrons in the atoms are more stable than others. These led to the development of another useful model of the nucleus called "Nuclear Shell Model", developed by Maria Goeppert Mayer of U. S. A., and O. P. L. Haxel, J. H. D. Jensen and H. E. Suess of Germany, in early 1950's, according to which the nucleons are moving in a nuclear force field in which each type of nucleon, proton and neutron fill up their respective shells separately. But their order of filling up is different from that of electronic shells. It is recognised that some shells are exceptionally stable. They are called magic numbers. Magic numbers of neutron and proton are generally recognised as 2, 8, 20, 28, 50, 82, 110, 114, 126, 184 and 196. Thus, if we plot the proton number and neutron number of the nucleus, we will find that the point of intersection of two magic numbers will give a stable isotopic zone compared to the isotopes of the nearby region.

This shell theory was further refined by combining it with 'Liquid drop model' by Swedish Physicist Sven Gosta Nilsson and others during the year 1959. This unified model now can predict many nuclear properties semi-quantitatively. With the help of this theory it has been shown that the near magic number shape of nucleus remains spherical or nearby spherical. Such nuclei are most stable against spontaneous fission. Recent theoretical calculations in the region beyond proton number 103 by using liquid drop model with shell correction from Nilsson's model suggested the existence of possible closed nucleon shells at atomic number 110 and 114 and neutron number 184, and these nuclei should be very stable against spontaneous fission. Once it survives spontaneous fission, other modes of decay, i.e., α-decay and β-decay become more important. Therefore, Nilsson and his associate Chin-Fu-Tsang calculated the stability of the nucleus against these modes of decay in this zone and their results are presented in Fig. 2 and Fig. 3.

In Fig. 2 half-life of different modes of decay of the element Z=114 is plotted as the function of number of neutrons. Here as the neutron number increases the life against spontaneous fission also increases, and reaches maximum at N=184 and 198 and life against-decay reaches maximum at N=184. Again the life against-decay becomes maximum at N=184 and at 197. Thus, for Z=114 the stablest nucleus will be at N=184. Similarly, in Fig. 3 half-life of different modes of decay for the nuclei containing 184 neutrons is plotted against number of protons (Z). Here we get two detectably stable nuclei at Z=110 and 114. Thus, Z=114 and N=184 represent an isotope which is quite stable against all sorts of decay. Its half-life for spontaneous fission is 10^{16} years, half-life for α - decay is greater than 1 year and that for β-decay is also high whereas the apparatus used to detect the super heavy elements, can detect a particle which exists even only for 10^{-8} secs. More hopeful is the isotope 110^{294}, It appears from Fig. 3 (star-mark position) that it is stable against all forms of decay with half-life of the order of 10^8 years for spontaneous fission and for α-decay. It is possibly stable against β-decay also. Comparing these with half-life of uranium decay 7×10^8 years, it is expected that 110^{294} may still exist on the earth if it was originally formed by the cosmic reaction that led to the formation of the earth and it is expected to be in the group of platinum metal. Therefore, searches have been started for element number 110 and some nearby members in naturally occurring platinum and its ore using very sensitive techniques in three leading laboratories of the world, namely, Lawrence Radiation Laboratory, Berkeley; Oak Ridge National Laboratory(ORNL) and Joint Institute of Nuclear Research, Dubna, U.S.S.R. So far no trace has been found and the technique of detention indicates that if it is at all present it must be less than one part in ten billion parts of platinum. Flerov and his associates in Dubna, however, claim that they have discovered spontaneous fission in lead sample that may be due to element number 114 (homologue of lead). In fact, around Z=110 to 114 if the half-life of α-decay be somewhat greater than that estimated in Fig. 3, then it is quite expected that they may exist in nature in trace.

Methods of synthesis of super heavy elements

Scientists are at present thinking of two techniques to produce super heavy elements : (1) Bombarding a neutron-rich transuranic nuclei with another neutron-rich relatively lighter nuclei of proper proton number such as—

$${}_{96}Cm^{248}+{}_{18}Ar^{40}={}_{114}{}^{284}+4{}_0n^1$$

$${}_{94}Pu^{244}+{}_{20}Ca^{48}={}_{114}{}^{288}+4{}_0n^1$$

But these techniques will barely reach the required mass number; (2) Two neutronrich nuclei of nearly the same size are fused together. After fusion the resulting nucleus undergoes spontaneous fission and the desired stable heavy nuclei will be one of the possible fission products:

$${}_{92}U^{238}+{}_{54}Xe^{136}=[{}_{146}{}^{374}]\text{—}{}_{114}{}^{298}+{}_{32}Ge^{72}+4{}_0n^1$$

But heavier the fusing nuclei the higher is their coulombic potential barrier to overcome before fusing together. In fact, for the last two nuclear reactions the projectile is to be given 1.5×10^9 eV energy. But no particle accelerator machine is at present available to give such a high energy. But both U.S.A. and U.S.S.R. may improve the existing machines to carry out such reactions.

The recent super-heavy elements 104, 105 and 126 deserve a special mention. The element number 105 which is expected to be grouped in group IV-B below Hafnium and, following the fashion of Mandeleev, may be called Eka-Hafnium. This element was synthesised by Flerov and his associates in 1964 in Dubna Laboratory by the reaction—

$${}_{94}Pu^{242}+{}_{10}Ne^{22}={}_{104}Ku^{260}+4{}_0n^1$$

Its half-life was 0.5 sec. Later on, Berkeley Laboratory prepared it using the reaction

$${}_{96}Cm^{248}+{}_{8}O^{18}={}_{104}{}^{261}+5{}_0n^1$$

(Half-life=1 minute)

Russians have already named it Kurchatovium.

Again Dubna Laboratory reported the synthesis of element number 105, Eka-Tantalum in 1967 using the reaction

$${}_{95}Am^{243}+{}_{10}Ne^{22}={}_{105}{}^{260/261}+5/4{}_0n^1$$

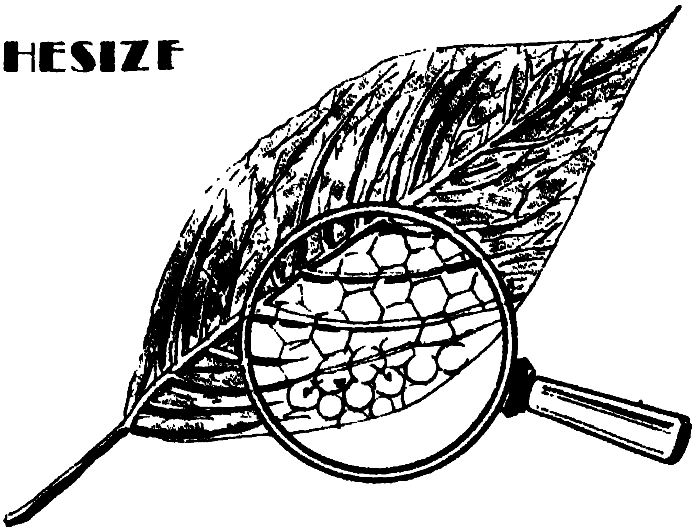
But this is still to be confirmed in other laboratories and the name Hanium has been proposed for it.

The story of the element 126 which is Eka-Plutonium is a fascinating one. It was around 1970 when Robert V. Gentry of ORNL got some sample of mica from Madagascar, which contained microscopic circular patches (30 to 60 micron; 1 micron= 1×10^{-4} cm) known as haloes. The haloes are always present in the rocks containing radioactive elements. It is due to the α-ray emitting radioactive inclusion and each α-ray emitter has its characteristics haloes. But some of the haloes of his mica sample were abnormally large (more than 110 micron compared to 30 to 60 micron which normally occurs), and could not be assigned to any known element, so he concluded that it must be due to some new element or elements present in these mica and the atomic number of the element should be around 120, i.e., it would be a super heavy element. In the meantime T. A. Carlson, C. W. Nester and their associates in the same laboratory theoretically calculated that the element 126 should give an X-ray line corresponding to 27253 eV energy. At last, at the beginning of 1976 a group of scientists notably, Robert V. Gentry of ORNL, Thomas A. Cahill of the University of California, Neil R. Fletcher and his group at Florida State University took the X-ray spectra of the giant haloes and got the line corresponding to 27250 eV, the difference from prediction is negligible and they declared the existence of the element number 126. Though the experiment itself is highly satisfactory, it still requires confirmation from other laboratories.

"The work on superheavy elements of the future has run into heavy weather at present"

(Continued on page 393)

NOW YOU CAN SYNTHESIZE A LEAF



The idea of devising synthetic leaf is to provide new impetus to develop devices for solar energy conversion. These artificial photosynthetic units can convert light energy into electrical energy

S. SEENI

TO absorb light is the primary act of photosynthesis. The main pigments of photosynthesis for absorbing light in higher plants are chlorophylls. Robert Emerson and William Arnold (1932) of the University of Illinois (USA), considered chlorophyll molecules to be distributed in the form of numerous clusters or units. Molecules of each group work together to bring out the evolution of O_2. This led to the concept of photosynthetic unit (PSU) : a group of 250-300 closely packed chlorophyll molecules capable of effecting a photochemical act. Functionally the chlorophyll molecules comprising the PSU can be divided into two types namely antenna and reaction centre molecules. They constitute 99% and 1% respectively of the total chlorophyll molecules.

Antenna chlorophyll molecules serve to absorb incident photons (light energy concentrated in small particles) of the sunlight. Light energy absorbed by the antenna chlorophyll is converted into electronic excitation energy which is transferred via adjacent chlorophyll molecules until it reaches the specialized chlorophyll *a* molecules, perhaps only two in number—called energy traps or reaction centres. The reaction centres utilize the excitation energy to pump electrons from electron donors to electron acceptors in the electron transport chain. The photosynthetic unit and the primary photoact at the reaction centre are shown in Fig. 1.

The *in vivo* mechanism of conversion of light energy by chlorophyll molecules in the leaf known as for the past few years has of late been analysed on an entirely different perspective by Dr. Joseph J. Katz and his associates at Argonne's Laboratory, USA. They have designed a synthetic approach to delineate the functions of chlorophyll in photosynthesis. The idea is mainly based on assembling a well defined *in vitro* system which is comparable in all respects to the *in vivo* preparations or even whole leaf cells. Their attempts have provided a new impetus to develop devices for solar energy conversion. The first elegant device of the kind developed and employed by the group to use the *in vitro* analogues of the *in vivo* components is a synthetic leaf. The synthetic leaf provides a simple system where the photosynthetic units are artificially constructed and the chlorophyll device so formed can convert light energy into electrical energy. It faithfully mimics the light conversion phenomenon in the leaf cells of higher plants.

In vitro synthesis of PSU

The Argonne scientists have proposed well defined models for the artificial synthesis of photosynthetically active antenna and reaction centre chlorophyll molecules respectively and their potential use in the synthetic leaf device.

(*a*) *Model for the antenna*: Chlorophyll *a* molecules, when suspended in aliphatic hydrocarbon solvents like carbon tetrachloride or octane, are capable of self-aggregation and produce oligomeric species that are active in transferring light energy. The formation of oligomers or dimers becomes feasible by the coordination of the magnesium atom in an acceptor chlorophyll molecule to the ring-V, ketocarbonyl group of adonor molecule (Fig. 2). Such a bonding permits the stringing together of many chlorophyll molecules to form long chains of antenna with the sequence chl/chl/chl/chl/chl/chl/.

(*b*) *Model for the reaction centre.* The long chains of antenna chloro-

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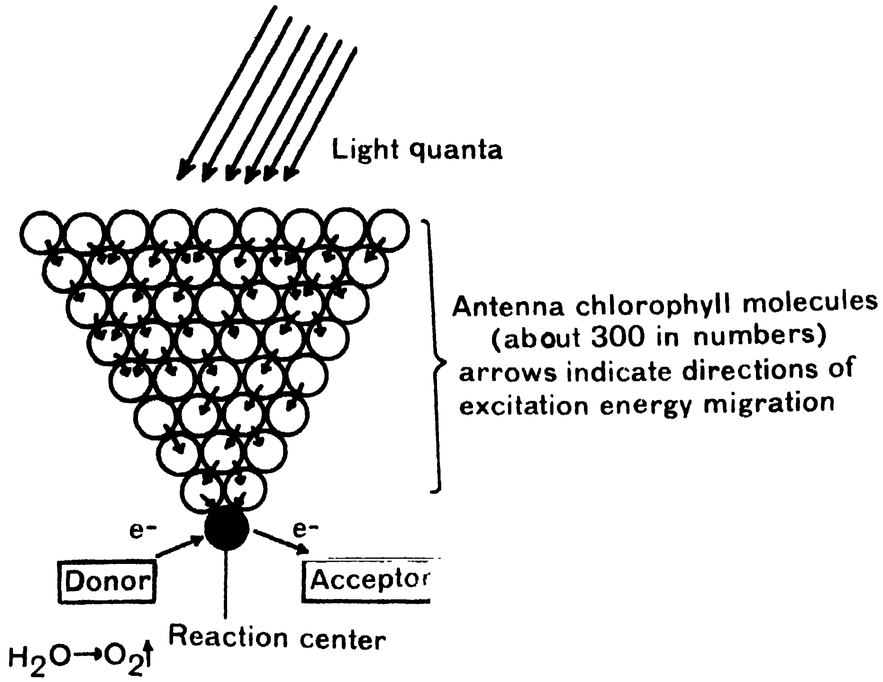
Light quanta
Antenna chlorophyll molecules (about 300 in numbers) arrows indicate directions of excitation energy migration
e-
e-
Donor
Acceptor
Reaction center
$H_2O \rightarrow O_2\uparrow$

Fig. 1 A photosynthetic unit

phyll molecules under the circumstances described can terminate in a particular pair of molecules that forms the photoactive centre through water adduction. In other words, when chlorophyll-water adducts are suspended in an aliphatic hydrocarbon solvent, water plays an important role in cross-linking a terminal pair of chlorophyll molecules to form a reaction centre. Water acts as a bifunctional ligand (an agent capable of donating electrons to a metal cation). It can coordinate to the central magnesium atom of a chlorophyll molecule with the available oxygen atom and its two hydrogen atoms are then freely available for binding to another chlorophyll molecule. The interaction of water with a chlorophyll oligomer results in the formation of adduct having the following structure : chl/HOH/chl. Such a chlorophyll-water adduct has been experimentally shown to be active upon irradiation.

The models of the antenna and reaction centres can be usefully combined to form PSU of the following structure which can act as an electron pump :

—chl/chl/chl/chl/chl/chl/chl

antenna

chl/HOH/chl

reaction centre

Synthetic leaf—its components

The synthetic leaf with its ability to convert light energy into electrical energy supports and makes use of the models described above. An outline diagram of this device is given in Fig. 3.

The synthetic leaf device is nothing but a type of photoelectric cell which employs chlorophyll as the primary element. It is a glass cylinder partitioned into two compartments by a plastic semipermeable membrane or aluminium foil. A chlorophyll-water adduct is impregnated in the membrane or deposited on one side of the metal foil by evaporation from an aliphatic hydrocarbon solvent like octane suspension of the adduct. The two compartments respectively are filled with an electron acceptor and electron donor (reducing agent) solutions such as tretramethylphenylenediamine and sodium ascorbate. Each compartment carries an electrode and the electrodes are connected to an external circuit via leads fused in the cylinder walls.

Synthetic leaf—its operation

The synthetic leaf, to start with, is thermally equilibrated in the dark. The photoactive chlorophyll impregnated on the membrane or the metal foil is irradiated with white or red light and one could easily record and analyse the electrical effects in the external circuit. Dr. Katz observed a potential difference across the cell on irradiation Also ob-

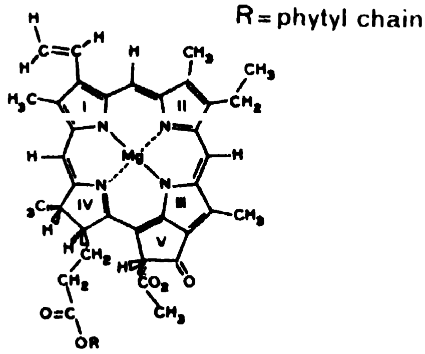

Fig. 2. Structure of chlorophyll *a* showing ring-V ketocarbonyl group

"And the priority should be on synthesizing tea leaves and betel leaves"

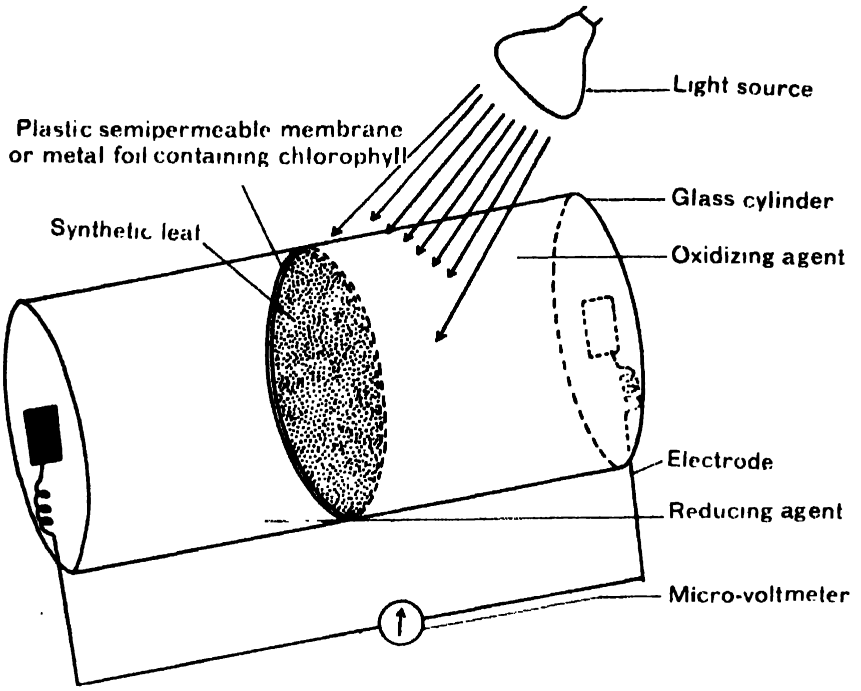

Fig. 3

served were the resistance increases in the conductivity and increased currents. He could detect upto a potential difference of 422 mv with a simultaneous current of 2.36×10^{-6} amp in the external circuit using an aluminium foil supported chlorophyll system.

Based on their proposed models, the Argonne scientists have interpreted the results obtained in the synthetic cell and compared them with the *in vivo* mechanism. Light quanta are easily harvested by the *in vitro* formed antenna chlorophyll molecules and the excitation energy is transferred to the special pair of chlorophyll (reaction centre) at the terminus where oxidation and reduction can occur. The terminal reaction centre consisting of chl/HOH/chl is a valid functional structure since the available evidences tend to point out that light conversion *in vivo* occurs at a special pair of chlorophyll molecules constituting the photoreactive centres. However it has not been unequivocally proved that the two chlorophyll molecules *in vivo* are linked water to form a kind of chlorophyll-water sandwich.

Synthetic leaf --supporting evidences

Modern spectroscopic studies provide the following supporting evidences for the functional integrity of the *in vitro* antenna—reaction centre chlorophyll system of the synthetic leaf :

(a) Optical spectra obtained from algae *in vivo* and chlorophyll *a* molecules in aliphatic hydrocarbon solvents are strikingly similar; (b) the *in vivo* chlorophyll is capable of forming species that are similar if not identical to *in vitro* chlorophyll; and (c) the pairs of chlorophyll molecules are capable of forming water adducts that are efficient photoactive centres. An amalgam of these effects, as one may think, yields a consistent mechanism for photosynthesis with the synthetic leaf which in principle mimics the *in vivo* phenomenon in green plants. *In vitro* devices such as synthetic leaf which mimic biological phenomena (in this case photosynthesis) can be rightly called biomimitecs.

"While he tries to make a leaf in the lab., I try to make a loaf in the kitchen"

Further reading

1. Govindjee and Rajni Govindjee (1975), Introduction to Photosynthesis, In: *Bioenergetics of Photosynthesis*, Academic Press, USA.
2. 'Synthetic leaf mimics plants' light conversion, *Chemistry & Engineering News*, Vol. 54, No. 7.

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OF REINDEER ANTLERS

Reindeer/caribou is unique because of its prominent, flattened, brow tine antlers above the nose. Antlers make it more competetive during restricted food supplies

THE reindeer (*Rangifer tarandus*) is a mammal primarily of arctic and sub-arctic distribution, although recently some herds have been introduced in the southern hemisphere. The North American counterpart of reindeer is known as caribou which is a sub-species of *R. tarandus*. Among caribou, there are two types which are distinguished from each other on the basis of their habitat. These are the barren-ground caribou that occupy the forest region of Labrador, and from Newfoundland to British Columbia (Kelsall, 1968). Reindeer/caribou are unique since their antlers are conspicuous by the presence of a single (rarely two), prominent, flattened, and palmately-lobed brow tine that stands above the nose. The presence as well as the form of this brow tine causes asymmetry of the head of the cervid. The following account highlights this aspect.

Morphology of reindeer antler

Reindeer differs from all other living deers from the fact that both the sexes possess antlers, although in the females they are smaller with fewer tines. In other deers, only the male develops antlers. According to J. Henshaw (1968) of the University of Alaska, antlers permit the females to be highly competitive during winter when tenable space is considerably reduced. These cephalic adornments enhance the social ranking of the females at a time when the males have shed their antlers, and enhance their abilities during competition for restricted food supplies, thereby contributing to their survival. It is also clear, according to Henshaw, that the functions of antlers in parent females are not even associated with the protection of the offspring or of the latter's quest for food during severe winter. This is due to the fact that the presence of antlers in the calves exhibit a marked degree of precocity and independence of maternal care during adverse seasons. However, the above theory will run into difficulties to account for the fact that in most reindeer populations, there are a few antlerless females. According to A.W.F. Bansfield (1961 of Brook University, Ontario, in some populations of forest caribou in North America and reindeer in Asia, the percentage of antlerless females may be as high as 40.

Antlers are solid, bony outgrowths arising from the frontal bones of the cranium. They have become almost status symbols and are used as offensive weapons by males during rutting season. They are ossified and so differ from

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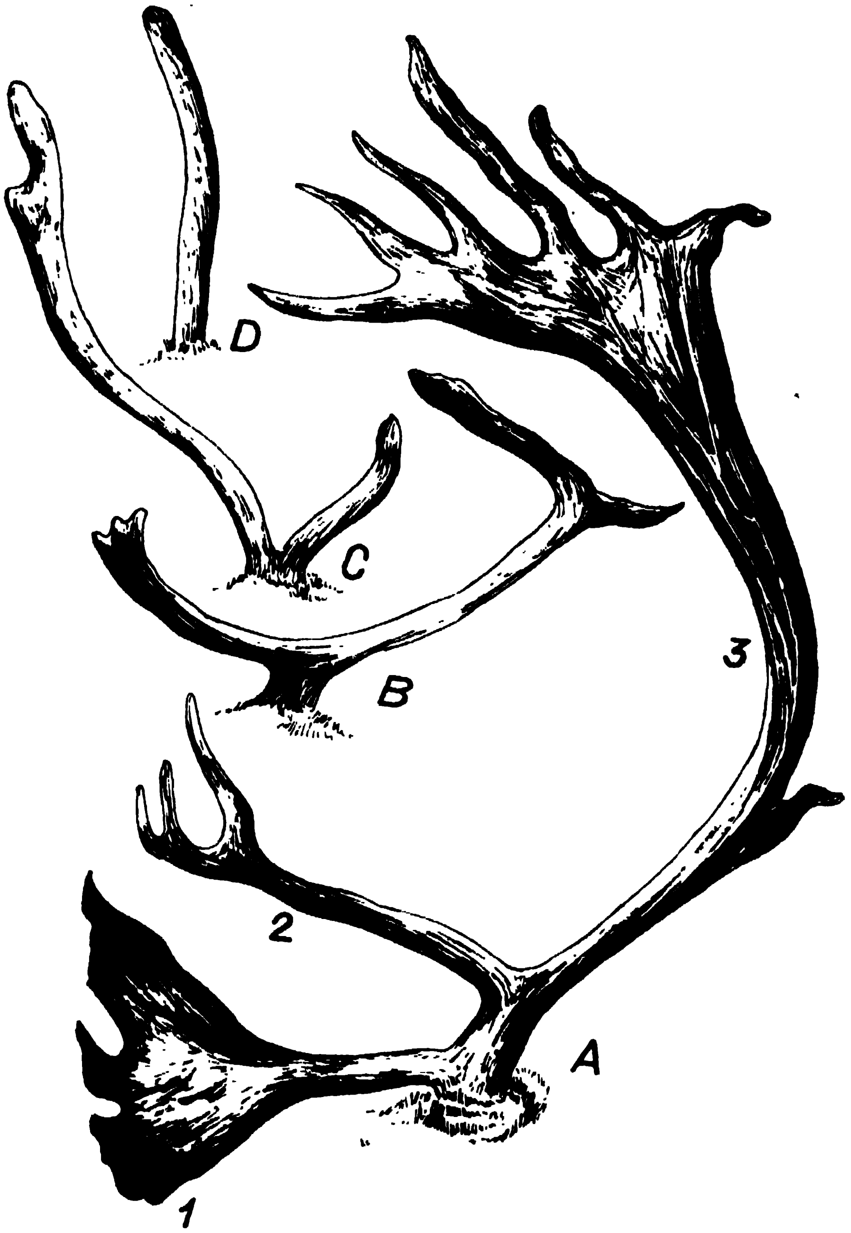

Fig. 1. (A-D) Four different types of antlers in reindeer/caribou: A, that of a healthy male showing prominent brow-tine, bez-tine and upper ramification. Young animals and females usually display antlers of types B-D

horns which are cornified. Further, antlers are branched, elongate on their ends, and are dead once they shed the velvet, while horns are generally unbranched, grow from their base, and are living.

In reindeer/caribou, only the basic antler pattern seems to be genetically controlled. Considerable differences in the morphology of the antler are brought about by differing nutritional levels. It is also well-known to trophy hunters that the mineral content of the soil and the availability of food control the size of the cervid antlers. In view of the great variability on antlers because of sex, age, nutritional level, physiological conditions arising from castration and pregnancy, as well as mineral content of the local soil, recent taxonomists do not consider antler formations as diagnostic characteristics of reindeer/caribou populations.

Antlers between individual reindeer/caribou, even within the same sex, show extreme variation in size, form and in the number of tines present. Not even the two antlers of the same individual are an exact mirror image of each other.

A reindeer antler comprises the lower tines and the upper zone of ramification (Fig. 1A). Although the upper zone is complicated and highly unstable, the lower region is somewhat stabilized. The lower branches are commonly termed the brow-tine (Fig. 1A$_1$) which is the first branch (where present), the second one is known as the bez-tine (A$_2$) and the third one, trez-tine. The bez-tine is generally well-formed and adapted as a protective shield not only for the eyes but also for the entire facial region. The trez-tine is oriented medial-posteriorly. In some individuals it is large and bifurcated while in others it is usually small (Fig. 1A) or even absent. The frequent damage to the third tine of the male reindeer/caribou indicates that it is often used. According to A. B. Bubenik (1972) of the Ministry of Natural Resources, Ontario, they serve as hooks or at least as foils which can parry or diminish the blows in the neck region of the distal ends of the rival's antlers.

The upper zone of antler (Fig. 1A$_3$) shows two kinds of ramifications which are the single beam (monopodium) with tines, or anterior and then posterior edge of beam: and the forked (dichotomous) beam. Beams and tines can grow in palms or fork to the third grade of branching.

In young animals, only a single tine represents an antler (Fig. 1D), and in females the antlers are usually simpler as shown in Figs. 1B and C.

Functions of the brow-tine

It is a common notion that reindeer make use of the brow-tine for digging out snow deposit to reach the lichen (*Cladonia* sp.)

known as reindeer moss, which is the staple food of the barren-ground caribou, especially during winter. However, it is definitely known that reindeer also use the feet for digging craters on snow-cover for the same purpose. The fact that the antlers in many of the reindeer are shed by December, that is, four to six months before the snow cover fully melts away, also invalidates the alleged use of the forwardly-pointing brow-tine of reindeer/caribou. Some zoologists consider that the brow-tine might serve as a sort of protective shield in the male's fighting.

Based on personal observations on *Rangifer tarandus groenlandicus* in northern Manitoba and *R.t. groenlandicusgranti* intergrades in northern Alaska, W. O. Pruitt Jr. of Winnipeg (1966) reported that the brow-tine is performing the vital function of protecting the caribou buck's eyes while he is engaged in epigamic antler-threshing activities. When preparing to engage in epigamic antler-threshing, the buck typically approaches a bush or patch of vegetation and lowers the head in the attack pose or 'antler-threat' pose. In this pose, the muzzle nearly touches the ground and actually points somewhat posteriad so that the long axis of the brow-tine is nearly vertical. The neck remains virtually immobile and the head is rotated from side to side so that each antler is alternately swept down and horizontally across in front of the animal. The stems of the shrub are stuck by each antler beam at approximately a right angle; therefore, they offer maximum resistance to the beam's progress. During these movements, the brow-tine describes an arc back and forth in front of the face. A fully developed brow-tine, almost an equilateral triangle in shape, very effectively sweeps a clear path through the branches and prevents them from raking across the buck's eyes. That the females do not engage themselves in epigamic antler-threshing activities may be in part due to the poor development, or absence of antlers in them. Moreover, the possession of antlers by female caribou varies regionally. For instance, in northern Labrador, essentially all have antlers, in southern Labrador, only about 50 per cent, in northern Newfoundland less than 50 per cent, and on the Avlon Peninsula in southern Newfoundland, only rarely caribou females have antlers. The variation in antlers is also suspected to be due to heredity and to nutritional and physiological history of the individual animal. Results of many investigations on white-tailed deer (*Odocoileus virginianus*) show that animals on heavily populated ranges, or individuals with inadequate nutrition may have shorter, narrower, thinner and more simply-developed antlers than deer having less crowded conditions and more adequate food supply.

According to Bubenik (1972), the brow-tine, especially the palmate one, is of great social significance. The regression of one brow-tine and the dominance of the other may be influenced by selective pressure. From an ethnological point of view, one well-palmated brow-tine is more advantageous than two, if the antlers are used as offensive weapons. The injuries of face skin and even those of the frontal bones seen in some males demonstrate clearly how dangerous a weapon the brow-tine of reindeer can be.

Asymmetry of the antlers

Whatever may be special function of the odd brow-tine, its form is interesting since in some individuals it is fully developed into a wing (*Cover*), while in others it is reduced to a simple narrow tine. In exceptional individuals, the extra outgrowth is wanting, or there may be two similar-sized brow-tines, one from each antler (Davis, 1973). It is furthermore interesting that in some animals, the extra or larger branch develops from the left antler (Fig. 3), and in others from right antler. Banfield (1961) reported a curious phenomenon on the handedness of the brow-tine. He found in 35 sets of barren ground caribou antlers the left brow-tine dominated in 69 per cent of the sample and the right in 23 per cent. The sample size, of course, was too small to make generalisations about the dominance of the left brow-tine. However, my own observations on caribou reindeer antlers from Alsaka, Canada and Europe only confirm Banfield's initial finding. Out of 32 sets of antlers examined in North America, exactly 75 per cent were left-dominants and only less than 19 per cent were right-dominants. When similar data obtained from West Europe

Table 1. Data on asymmetry of reindeer/caribou antlers

Location	Dominance of antlers			Total
	Left	Right	Symmetric	
U.S.A. and Canada	24	6	2	32
West Germany	60	37	14	111
British Museum (Natural History)	39	23	6	68
Total	123	66	22	211

were pooled, the percentage dominance of the left brow-tine is reduced. That is, out of 211 pairs of antlers examined, 58.3 per cent were left-dominants, 31.3 per cent were right-dominants, and the rest were bilaterally symmetric (or natural ones) as the data in Table 1 reveal. The difference between the left- and right-dominant pairs of antlers is statistically significant, which calls for a definite cause (or causes) influencing the asymmetry.

As antlers are deciduous, one would have the curiosity to ask whether an individual animal which shows one type of brow-tine, say, left-dominant would continue to display the left dominance in the antler crops of the following and subsequent years or change to right dominance. Observations made, though on a limited number of animals, indicated no uniform results. For example, J. R. Luick of the University of Alaska observed a male reindeer Pierre having a left-dominant brow-tine in 1969 and 1971, but a right-dominant brow-tine during the alternate years of 1970 and 1972. The most active researcher on the subject is Richard J. Goss of Brown University, Rhode Island, who continues to examine from 1971 the morphology of antlers developed each year on a number of caribou/reindeer. He wrote (personal communication) that in these animals sometimes the same pattern is produced from one year to the next, but in other cases, it is not. He is inclined to believe that this is a random phenomenon. However, more data covering many years are required to confirm this.

In this connection I wish to present some interesting data obtained by L. N. Acharjyo of the Nandankanan Biological Park, Orissa on how the antler size gets affected as a result of partial amputation of a limb in Sambar deer (*Cervus unicolor*). It was inevitable to ampute the left-hind limb of a young Sambar through the meta-tarsal in February 1969 before the development of antlers. The maximum lengths of the left and right antlers for the crops for six years (1970-75) are given in Table 2.

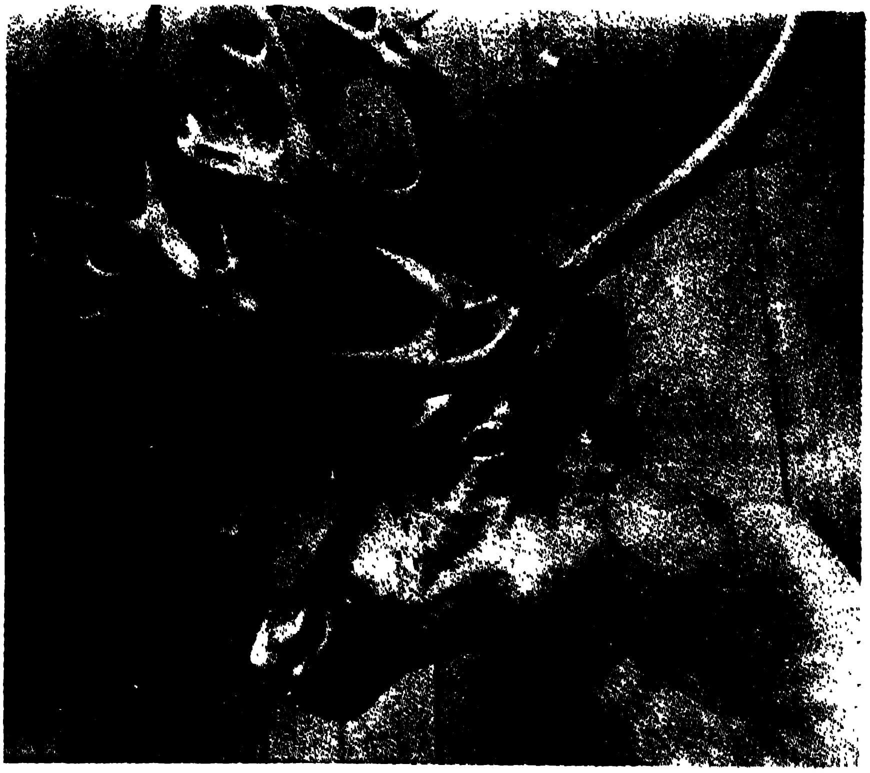

Fig. 3. Caribou head in Alaska showing a left dominant brow tine

It is obvious from data in Table 2 that compensation in the size of antlers is effected to cope with a weak limb as a result of amputation. The weights of antlers produced during the six years also showed striking differences between the ones on the left and right side of head. These data only suggest that the dominance of the left antler in reindeer/caribou reported in this paper is not accidental.

(*Continued on page* 390)

Table 2. Maximum lengths of left and right antlers in a Sambar deer

Year	Length of antlers in cm.	
	Left antler	Right antler
1970	14.5	7.0
1971	35.0	12.0
1972	43.5	11.6
1973	47.5	17.0
1974	55.0	22.0
1975	56.0	21.5
Mean	42.6	15.2

SCIENCE SPECTRUM

Satellites and figure of earth

SINCE his birth man has wondered about the form, figure and dimensions of earth. The prehistoric man, if he at all thought about this subject, had presumably concluded that, apart from local irregularities like rocks, mountains and depressions, the earth was flat. He had based this conclusion on his limited field of view in the absence of any mechanical device to rise high and see a large portion of earth.

It appears that neither the Babylonians nor the Egyptians favoured the idea of a nearly spherical earth. The credit goes to Pythagoras and his school of sixth century B.C. who thought (as a result of belief and not by direct observations) that the sphere was the only 'perfect' shape possible. It was Eratosthenes, about 300 years later, who actually measured the earth's circumference by what may be called 'the propagation velocity of a camel caravan'. He noted that the sunrays at noon in mid-summer were along the vertical walls of a well at Syene (now Aswan on Nile river) but were not so in Alexandria at the same time (Fig. 1). He found that angle made by sunrays at Alexandria was 1/50 of a circle, i.e., about 7.2°. He measured the distance between Alexandria and Syene carefully by repeated measurements of travel time of camel caravans and found this to be 5000 stadia. Knowing the relationship between the arc, the radius of circle and the subtended angle he found the value of radius of the sphere to be 50 × 5000 = 250,000 stadia, which is about 125,000,000 ft. This value of the radius of earth sphere is about 15 per cent higher than the present value but is of considerable significance considering the equipment used and the assumption that earth is a perfect sphere.

The modern scientific definition of the figure of earth excludes surface irregularities like mountains and valleys or depressions. It is

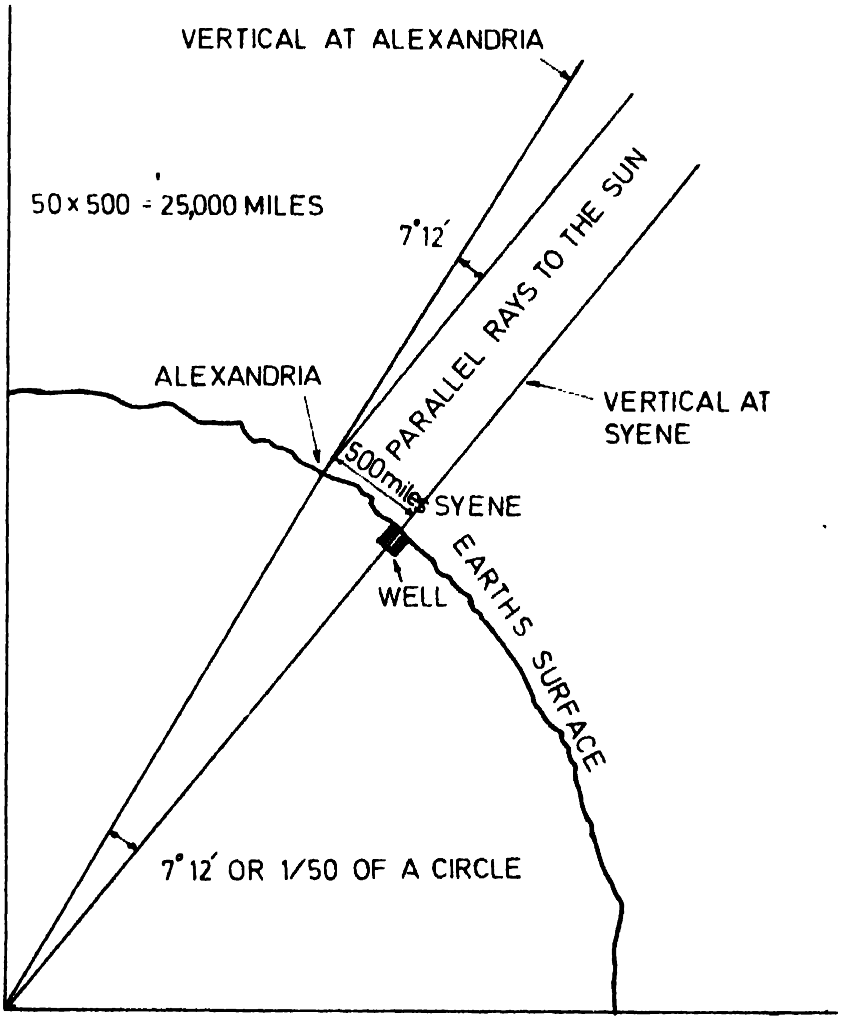

Fig. 1. Erastosthenes method for determining the size of the earth

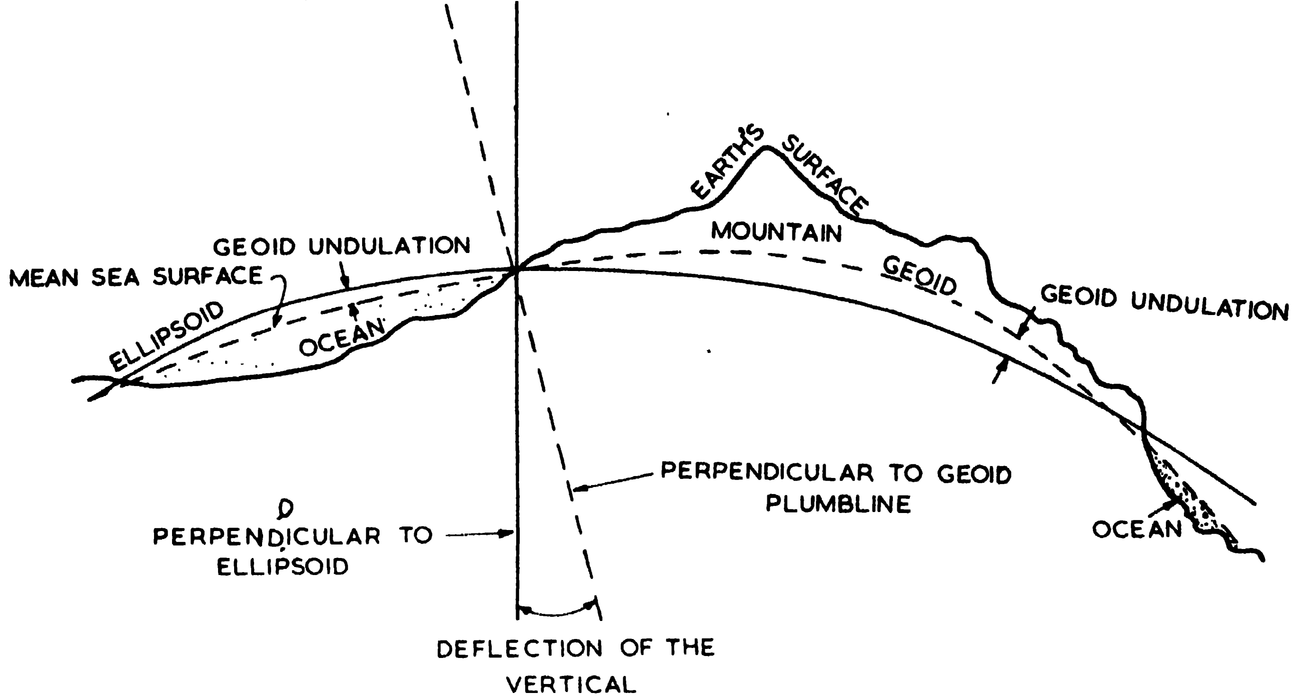

Fig. 2. Geoid ellipsoid relationship

defined to be the shape of surface of mean sea level, the surface being determined by force of gravity, which includes gravitational attraction and the rotation of earth around its instantaneous axis of rotation. We can imagine this surface to be generated by sea level extended into the continental areas through imaginery canals going below the land masses.

Such a hypothetical surface is called 'Geoid'. It is the surface which the sea level would acquire if it were allowed to continue all over the continental areas. The geoid will be a very irregular surface (Fig. 2) due to the irregular mass distribution of earth. Such a surface is not suitable for computation of positions (planimetric), such as latitude and longitude, although this could and is used as a reference datum surface for height of a point on the land portion of the surface of the earth. For computational purpose we need a smooth surface which can be described mathematically. The choice was obviously to use an ellipse of rotation about its minor axis, called ellipsoid, also sometimes called 'Oblate spheroid'. The distinguishing feature of the ellipsoid is the property known as 'flattening' which is defined as:

$f=\frac{a-b}{a}$, where a and b are the semi-major and semi-minor axis respectively.

This flattening is a measure of the oblateness of the ellipsoid. Sir Isaac Newton obtained a value of $\frac{1}{230}$ from purely theoretical consideration. The present adopted value is $\frac{1}{298.258}$ as obtained from satellite and other geodetic measurements. Several attempts have been made, since the time of Newton, to determine the equatorial radius 'a' and the flattening. The underlying principle of these attempts was to measure the length of arc of 1° near the equatorial and polar regions. These arc measurements yielded a value of $a = 6376428$ metres and $f = \frac{1}{311.5}$. Such measurements were made under the assumption that the mass of earth is uniformly distributed. This, however, is not the case. As a result the plumb-line, e.g., the direction of gravity and the normal to the ellipsoid, are not in the same direction (Fig. 2), the angle between the two being defined as 'deflection of the vertical'. The separation between the geoid and the ellipsoid, measured along the ellipsoidal normal, is known as 'Geoidal undulation' and denoted by the symbol N. It is an attempt of the Geodetists to determine the parameters a, f, N and the two components of the deflection of the vertical (in the north and east directions) denoted by ϵ, η such that the ellipsoid best fits the geoid. No single ellipsoid fits best for the whole globe. Several ellipsoids have been adopted for different parts of the earth. The ellipsoid best fitting Indian subcontinent is known as 'Everest Ellipsoid' and is used for the computation of Indian subcontinent network. Table 1 gives the various ellipsoids used in various parts of the world.

Table 1

Ellipsoid Name	Equatorial Radius 'a' in meters	Flattening	Where used
Krassowsky (1940)	6,378,245	1/298.3	Russia
International (1924)	6,378,388	1/297.0	Europe
Clarke (1880)	6,378,249	1/293.5	France, Africa
Clarke (1866)	6,378,206	1/295.0	North America
Bessel (1941)	6,377,397	1/299.15	Japan
Airy (1830)	6,376,542	1/299.30	U.K.
Everest (1830)	6,377,276	1/300.8	India

The main reason for different ellipsoids is the anomalous mass distribution, i.e., variation of gravity from place to place. It is here that the satellites have helped a great deal in arriving at a more precise value of the equatorial radius and the flattening. As the man-made satellites go round in inclined or polar orbits, they are effected by the varying earth's gravity. As a result the satellite orbit is altered. This perturbation can be used to determine the geometry of the earth. Mathematically, the gravity at a point can be expressed as an infinite series, consisting of complex terms involving the latitude and longitude of a point, its distance from the center of earth and other parameters.

The value of gravity can be obtained from satellite as it moves and behaves under the Newtonian laws of motion. The change in the gravity can be determined as the satellite orbit changes due to changes in earth's gravity as the satellite passes over it. These changes in gravity can mathematically be equated to the changes in the elements of a satellite orbit, namely, (i) the orbital inclination (i), (ii) the orbital period (T), (iii) the eccentricity (e), (iv) the argument of perigee (w), (v) the longitude of the ascending node (Ω), and (vi) the time 'T_0' of the perigee pass. The results, as obtained till 1970, from satellite observations are :

$$a = 6378140 \quad N_{max} = \pm \quad 100\,m$$
$$f = 1/298.258$$

The satellite observations have revealed the following :

(a) The earth's equatorial diameter exceeds the polar diameter by 42.77 km which is 170 meters different for the earlier value obtained from non-satellite observations.

(b) There is a depression around the South Pole, a bulge south of the equator and also around the North Pole indicating that the earth is 'Pear shaped' (Fig. 3).

(c) There is a depression south of India, of about 113 m, elevation near New Guinea (81 m) and the elevation centered in England and south Atlantic. While we could describe the shape of the earth and its gravity field by 4 parameters in the pre-satellite era, today in the age of computers and satellites, we use as many as 250 parameters to describe the pear shapedness of our earth.

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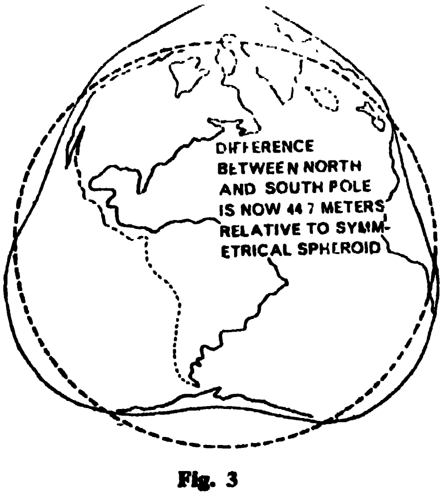
DIFFERENCE BETWEEN NORTH AND SOUTH POLE IS NOW 44 7 METERS RELATIVE TO SYMMETRICAL SPHEROID

Fig. 3

Puzzlers from cosmos: Y-ray bursts

About 13 years ago two *Vela* satellites were launched to keep a watch on the signatories of the 1963 Nuclear Test Ban Treaty. In the orbit of earth, the detectors the satellites were carrying, each "watching" a hemisphere, could tell whether a nuclear device has been exploded or not by monitering the nuclear radiations. In 1969 when the data they had picked up in 1967 was studied, there lay a surprise for astrophysicists and astronomers. Today that surprise, an astronomical serendipity, has become one of the stimulating problems in astrophysics. It is called. cosmic gamma ray burst. It has been found that powerful bursts of gamma rays whose origin is somewhere in the vast cosmos occur infrequently. While they last, only for nearly 10 seconds or so, they dominate all other celestial sources of gamma rays.

Since the discovery about 55 such bursts have been recorded and, on an average, a dozen every year. As for gamma rays it is well-known that they are electromagnetic radiations emitted spontaneously during nuclear fission or fusion. Also, their origin could be thermal radiations or energetic neutrons. The bursts of such rays are so powerful that, ironically enough, nothing is yet known about them. For want of adequate data their position in the sky, their distance, other characteristics, and the astrophysical phenomenon producing them—all could only be guessed.

Astrophysics, or, for that matter astronomy, is the subject which is totally dependent upon observations, in particular upon spectroscopy, in interpreting the characteristics of a celestial object from the radiations it is emitting. In so far as the "spectral signatures" of cosmic gamma rays bursts are concerned, nothing is known except that all appear alike. It has, however, been found that each burst comprises of one to five or more distinctly separate pulses, each lasting for 0.002 to greater than one second. Astounding is the finding that the pulses start or stop within a few milli-second, reaching their peak within the same time. It could be inferred from this that the diameter of the source of these bursts is not much, in the range of 300 to 1500 km only, which is many times smaller than the earth's diameter.

It has been ascertained that, on an average, each burst contains 10^{-4} erg/sq. cm/sec. of energy. Estimating from this value the energy generated at the source, it is found that it depends upon how far the source is from us. For instance, if the source is at the same distance as that of the nearest star, nearly 3.6 lightyears away, then 10^{34} erg/sec of energy might be getting generated at the source; if the distance of the source is taken as 1000 parsec (3260 lightyears) then the energy-generation value at the source is estimated about 10^{40} ergs/sec. The latter value is some million times greater than the total sun's energy radiations ! In case the source of the bursts is still distant, say, in other galaxies, then the energy generated at its source would be many orders of magnitude more. At this rate, if we consider that the size of the source is smaller than that of earth, a unit of it would generate energy 10 billion times that released by a unit of sun's surface !

Though distances of the sources are still vague, the most probable guess is that they are some 1000 parsec away.

Models

What might be causing the cosmic gamma ray burst is still a mystery. About 30 models, galactic and extra-galactic, arising due to the uncertainty prevalent in the distance, have been put forward, though none could be singled out as flawless.

For obvious reasons, the extra-galactic models, that assume the sources of the bursts outside our galaxy *Milky Way*, were the first to be propounded. It was Stirling Colgate of New Mexico Institute of Mining and Technology, U. S. A., who claimed that they arise due to supernova explosions. As a star begintos collapse, to produce an explosion (*S.R.*, Oct. 76), its density begins to decrease, while subsequently the velocity of shock waves that it generates increases. The incoming X-rays as a result achieve relativistic velocities, which get Doppler shifted to produce a pulse of soft γ-rays. This model, though appealing, does not stand valid as it does not account for either the high energy emitted in the burst or the fine structure of the pulse.

The second extra-galactic model comes from J. Cohen, of University of Pennsylvania, and Reuven Ramaty, of Goddard Space Flight Center. According to them bursts are given off during the collapse of a white-dwarf star into a neutron star. When a white-dwarf star accretes matter from the surrounding space, so much so that it cannot stand any more due to the gravitational burden plied on itself, it begins to collapse rapidly. While its density approaches to that of a typical neutron star, about 10^{14} gm/c.c., its surface temperature approaches 10^{9} degree K. In this state the object becomes a source of soft γ-rays, emitting them in flashes. This model is, however unable to explain why the bursts occur randomly as observed. Though such a collapse as mentioned could occur in any galaxy, even in our own, the frequency of such happenings is too low to explain the large number of the observed random bursts.

The most galactic models, that explain away the bursts production in the celestial sources present in a galaxy, are, however, superficial. In fact, to call them models, based on so minute details, would be a misnomer. Nowadays, such models are preferred to be named as scenarios. Most of them are a result of the superficial similarities observed between solar flares and γ-rays bursts. It has been claimed that X-ray bursts are generated when low-energy photons are accelerated to higher energies during a flare occurring in a commoner type of star; or when putative flares on a white-dwarf star react with strong magnetic fields. There are also some scenarios which attribute the bursts to the interactions taking place between the hypothetical antimatter and matter, relativistic dust particles and photons, etc.

Attributing every anamolous happening in the cos- mos to a mysterious glamourous- looking pulsar has become a craze with astrophysicists. So the craze has not obriated the possibility that the cause for the bursts is a pulsar. Nothing, of course, could be said presently whether this 'connection' would prove one day correct or not. The suggested models are certainly convincingdue to the mystery surrounding both the "emis-

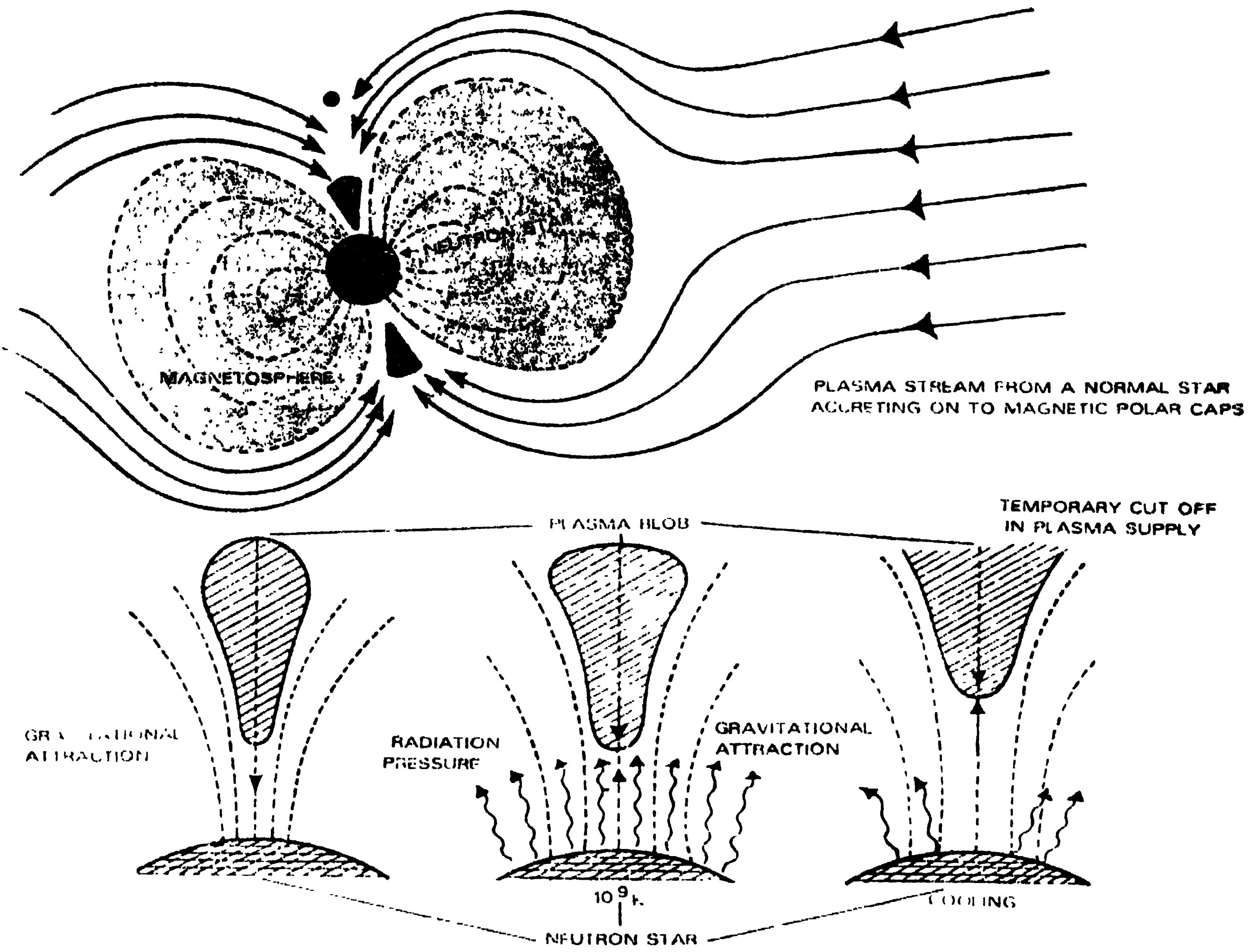

Fig. 1

sion", the γ-ray bursts, and the "generators", the pulsars. The strongest objection as to why a single burst location does not coincide with a position of a pulsar is also nearly ruled out by claiming that there are still a large number of pulsars or neutron stars which are yet to be detected.

Pulsars are neutron stars with strong magnetic fields. They spin and produce radio pulses at precise intervals. As it is estimated that the magnetic field in the vicinity of a neutron star is too high to account for γ-ray bursts, it is claimed that "glitches" produce them. Whenever there is a sudden change in the rotational speed of a neutron star, a "glitch" is said to occur. According to Franco Pacini of European Southern Observatory, and Martin A. Ruderman, of Columbia University, the energy dissipated during a "glitch" is low enough to produce a γ-ray burst. It is, however, still inconceivable how this comes about. This is the handicap of the model and that is why other models that consider the pulsars as the origin for the γ-ray burst appear equally good. Starquakes, volcanic activity, or sudden changes in size or shape, or like phenomena, according to them, occur also on a neutron star producing the requisite γ-ray bursts randomly.

The most appealing, and seemingly cogent, model is the one that claims that γ-ray bursts could be produced when matter from somewhere, say, a normal star, is swept off on to the surface of a nearby neutron star or white dwarf star or black hole. It is a well-known fact that one hydrogen atom falling onto a white dwarf produces one million electron volt energy (MeV), while on a neutron and black hole it is about 100 MeV. This same scenario has been conceived of in a variety of ways. One of the most accepted is that blobs of plasma (accreted from some nearby source) hang over the magnetic poles of a neutron star, just as a magnet of opposite polarity could. Whenever a glitch occurs, it allows the blob to fall down to restore equilibrium and when the glitch is overcome the blob assumes its normal position. In the process of falling down, when the acceleration takes place, the γ-rays bursts are generated.

Some evidences are also presently leading to the view that Cygnus X-1 might be the source of the γ-ray bursts. It is well-known that this X-ray source is a binary star whose one component has collapsed to form a black hole. It is, in fact, the accretion of matter from the normal star on to the black hole that X-rays are, it is claimed, being produced (**x-ray binaries**, Aug. *S.R.*, 75). So, now, it is conceived that γ-ray bursts might also be produced when two infalling streams of plasma interact with the black hole (Fig. 1). If this connection between an X-ray source and γ-ray bursts is settled once, these bursts would prove to be a handy tool in detecting more black holes and in better understanding of the X-ray stars. Presently, only a few evidences suggest so. For instance, in March 1971 and twice later, whenever bursts were observed, there was found a change in the X-ray radiation given off by this source. Also, twice, the direction of γ-ray bursts has pointed within 20 degree square area surrounding this source. All these could, doubtlessly, be coincidences. The best is said in the words of Ian B. Strong and Ray W. Klebesadel (*Scientific American*, October 1976): "One might say that the evidence is sufficient to indict but not to convict." The puzzle will continue to intrigue, let's hope, not for long.

DILIP M. SALWI

Sedimentation problem in Indian reservoirs

WHEN a dam is constructed, a reservoir or an artificial lake is formed. Conservation of water, in these reservoirs, finds applications in power generation, irrigation, flood control, water supply, etc. Multipurpose reservoirs, built at great costs for the economic development of a region, are invaluable national assets because dam sites are scarce. Water in the reservoir basin is collected as the run-off or surplus water through the drainage network in the area. This run-off from the catchment area carries sand and silt load along with it into the reservoir basin. As the water is stored in the reservoir its capacity to hold sand and silt gets completely lost causing the sediment to settle down on the bed of the reservoir. The rate of silting in the reservoir depends on the amount of erosion in the watershed and the capacity of the streams to transport the eroded material into the reservoir. The amount of erosion, in turn, depends on the various physical factors, viz, intensity of rainfall, topography, soil, vegetation, landuse, hydro-physical conditions of the drainage network, etc. The accumulation of silt not only reduces the storage capacity of the reservoir, but also affects the life of the reservoir.

The high erosion rate in the watersheds of the reservoir plays an important role in silting. Soil erosion became a problem due to man's interference with the environmental processes. Cutting and burning of forests, overgrazing of grasslands by ruminants, unwise agricultural practices, deforestation and improper methods of tillage have added much to this grave problem.

Scientific studies have shown that average rate of sedimentation decreases as the size of the watershed increases. Also, the larger the watershed, the higher is the possibility of sediment deposition occurring in the way to reservoir. Amazingly, both high and low rates of sedimentation have been observed in small watersheds. A small watershed may entirely be restricted to a forested area producing low rate of sedimentation or to a cultivated area causing high sedimentation rate. Rain-fed streams are responsible for high sedimentation rates while snow-fed streams are involved with low rates of sedimentation.

Silting in Indian reservoirs

The catchment areas of various river valley projects in India mostly occupy the mountainous tracts which due to broken and uneven topography, steep slopes, especially in the Himalayan region, are susceptible to erosion processes. Deforestation and devegetation in Sivalikas and Himalayas have resulted in flashy floods destroying fertile agricultural land and silting up of the reservoir.

The data available on the silting in Indian reservoirs depict alarming rates as shown in Table 1.

Some silting occurs in a reservoir because of the sediments brought by the stream into it. For this reason some percentage of the total capacity (nearly $\frac{1}{4}$th) of the reservoir is left as dead capacity, during its construction. On the basis of assumed rate of silting, the life of a reservoir is estimated, and, the assumed rate of silting is calculated on the basis of gross erosion in the catchment area. While the observed rate of silting is measured after utilisation of the reservoir, any increase in the assumed rates of silting directly affects the storage capacity and the life of the reservoir.

Table 1 shows the highest silting rate (about 23 times the assumed rate) in Nizamsagar which has lost almost 40% of its live storage capacity. The Ukai and Maithon reserviors register 8 to 9 times the assu-

Table 1

Reservoir	Net catchment Area (Sq. miles)	Annual rate of silting in acre-ft. per 100 sq. miles	
		Observed	Assumed
Bhakra Nangal (Punjab)	21960	129	90
Maithon (D. V. C., Bihar)	2010	300	34
Tungbhadra (Karnataka)	10735	382	90
Nizamsagar (A.P.)	7152	137	6
Ukai (Gujarat)	240025	230	31

Source: International Hydrological Decade, *News Letter*, 1972

med rate of silting. Tungbhadra shows about 4 and Bhakra about 1.4 times the assumed rates. The causes responsible for such high rates have already been mentioned and we find that Nizamsagar occupies a small catchment area and contributes highest silting rates of all the Indian reservoirs. Another investigation is being made in these highly silted reservoirs regarding the volume-weight relationship of the sediments deposited in the reservoirs, because the volume occupied by the same weight of sediments varies from place to place depending upon the type and amount of erosion in the watersheds. This study would help in planning the future storage capacity of these reservoirs.

In the light of the above study, it becomes all the more important to take up soil conservation and other measures in the watersheds of the various reservoirs.

Steps suggested

(a) Construction of roads in hilly areas with provision for soil conservation measures to arrest unstable hill slopes left after the construction of roads;
(b) Forest management in the catchment areas by checking overgrazing and indiscriminate lopping of trees;
(c) Introduction of conservation farming in watersheds region.
(d) Cropping of terraced area, and ensuring minimum soil loss due to soil cover;
(e) Construction of check dams and points across the tributaries that contribute a major portion to sediment load;
(f) Measures for controlling gully erosion; and
(g) Preventing annual fires practised by tribals in the hilly areas.

It has been observed that the rate of silting decreases with the age of reservoir because sediment accumulation occurs mostly in the back water area at the head of the reservoir and results in the gradual formation of a delta. The delta may soon become covered with vegetation that may help in reducing the amount of sediments entering the reservoir. However, the transpiration losses from these vegetation covers should not be considerable enough to affect adversely. In extreme cases where a reservoir has attained silting to an extent that its capacity falls below its useful storage, the possibility of constructing a dam higher up the main stream may be investigated.

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Medical uses of chelating agents

METALS are the most insidious pollutants because of being non-biodegradable. Certain metals may be beneficial or harmful to man depending upon their concentration and chemical composition. Many disorders, including chronic and acute toxicity, are due to heavy metal ions. In some of them, essential metal ions are accumulated in the body in toxic amounts.

The customary methods used to remove such toxic metals from different sites in the human body involve administration of suitable chelating agents. In the human body, these chelating agents react with the toxic metal (and, generally, with non-toxic as well) which are excreted out of the body by different routes. Those chelating agents which facilitate the urinary excretion of metal ions are called renal chelating agents Likewise, a chelating agent which enhances the biliary excretion of a metal, or removes it from entero-hepatic circulation, is called entero-hepatic chelating agent.

Most chelating agents presently used for the removal of toxic metals from the human body are unselective in their action. The main excretory routes are either urine or feces, although some is also excreted through skin and hair.

In some cases fecal excretion is enhanced via the oral administration of an undigestible polymer containing chelating sites. It is capable of removing toxic ions by forming a stable complex with them. The latter is passed out through the intestinal tract.

The systematic search for chelating agents was based on two independent studies. The first was the development of an antidote to the poison gas, Lewisite, used during the Second World War, and the second on the development of polyaminocarboxylic acid chelating agents. Lewisite is an organo-arsenic compound which affects lung, skin or any part of the body. It inactivates -SH groups of the enzymes which metabolise pyruvate. It was observed that the enzyme activity was restored *in vitro* by the use of an antidote, BAL (British Anti Lewisiste). BAL was also used against poisoning due to lead and mercury. Since BAL was toxic, another chelating agent unithiol (2, 3-dimercapto-1-propane sulfonic acid) was developed. The chelating properties of unithiol are quite similar to BAL. It forms fairly stable complexes with almost all cations forming insoluble sulfides and increases urinary excretion of arsenic, mercury and lead. Unlike BAL which facilitates entry of mercury into brain, unithiol concentrates mercury in liver and kidney and excretes it out through urine.

The development of polyaminocarboxylic acids as chelating agents took place with the sole aim of having a wider spectrum. Such chelating agents are shown in Fig. 1. They form stable complexes with many of the essential as well as toxic metal ions in the body. They are mainly used in the treatment of poisoning due to cadmium, iron and manganese and are administered intravenously or intramuscularly.

D-Penicillamine and N-acetyl penicillamine are chelating agents of low toxicity. They form reasonably stable complexes with a number of toxic heavy metals specifically mercury, copper, lead and gold.

Several types of chelating polymers (effective in reducing the toxic

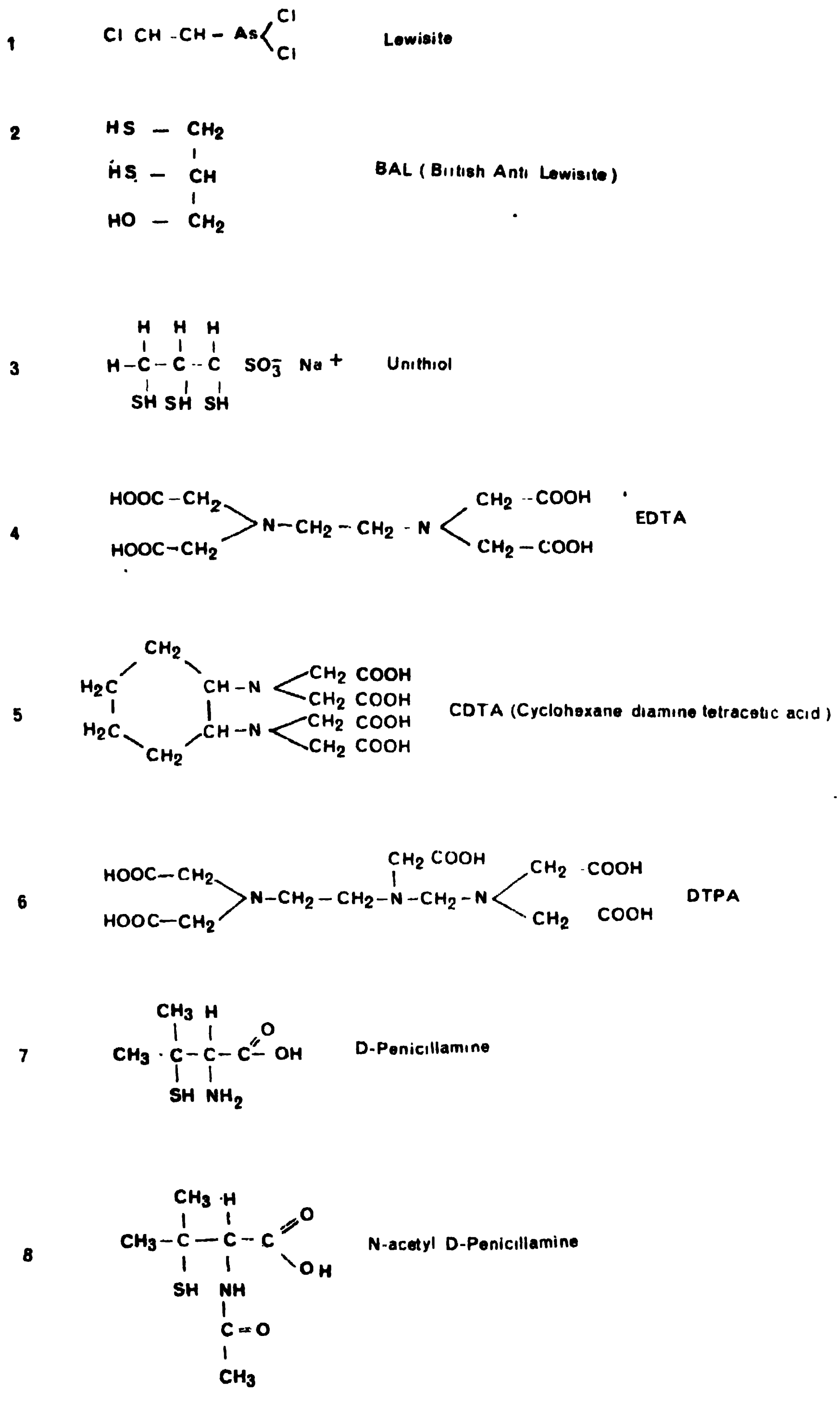

Fig. 1

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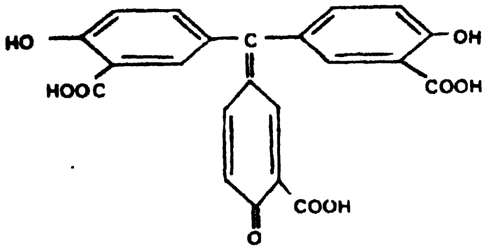
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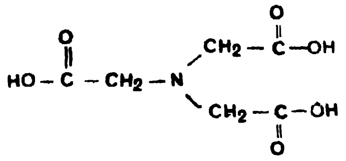
NTA (Nitrilotriacetic acid)

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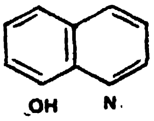
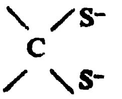

8 Hydroxyquinoline

Fig. 1 (*Contd*)

effects of mercury) have been developed. All of them contain sulfur either as —SH groups or


groups .

Body's own chelating agents

It is sometimes difficult to get a chelating agent suitable to form complex with the toxic metal in the body. The water solubility of most chelating agents prevents their penetration into the intracellular area of such tissues as liver and kidney. In such cases, the body is induced to form its own chelating agents by injecting small amounts of metabolic inhibitors. These agents formed within a tissue are in a more favourable position to come in contact with the metal ions. The best example is citric acid which forms a very good chelate with lead ion. However, even after injecting a huge amount of sodium citrate into an animal poisoned previously with lead, no protection against lead could be achieved. This occurred due to rapid metabolic destruction of the citric acid. But with the injection of even trace amounts (1 ml/kg) of fluoroacetic acid (which is not a chelating agent), a reasonable protection against lead poisoning was observed. This is because fluoroacetic acid interferes with the Kreb cycle, and in doing so builds a 'pile up' of citric acid in organs such as spleen and kidney and forms complex with excess lead ions.

Metallothionein is another chelating agent which is developed by living organisms. It consists of two parts, i.e., the metal part which may contain several metals like cadmium, zinc, mercury and copper and the metal-free protein part (called thionein) having 26 sulfhydryl residues for binding metals. Since three sulfhydryl groups bind each metal atom, it is postulated that thionein can hold up to nine metal atoms.

Problems in the use of chelating agents

The major problem associated with the use of chelating agents is a wide variation in their toxicity. Most chelating agents increase concentration of toxic metals while passing through kidney and add to its burden. In some cases chelation has been observed to enhance toxicity of a metal ion. BAL transfers cadmium from other tissues to the kidney where it causes a great damage by increasing non-protein nitrogen in the blood serum.

Some metal chelates stable *in vitro* may not be completely stable under physiological conditions. There is evidence that even chelates with exceptionally high stability are dissociated *in vivo*. The ferric chelate of EDTA, having a stability constant of 25, is broken down in the gastrointestinal tract. This could be an effect of low gastric pH. Likewise, lead forms stable *in vitro* chelates having a stability constant around 18, but this is also broken down in the gastrointestinal tract.

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Ashvagandha—an ancient Indian drug

ASHVAGANDHA is an ancient Indian drug which finds popular use as a convenient home remedy for many ailments. Botanically, it is *Withania somnifera* Dunal, and belongs to the *Solanaceae*, a family reputed for many alkaloid-yielding plants. Some of its vernacular names are: Hindi: *Asgand, Punir;* Tamil and Malayalam: *Amukkiram ;* Telugu: *Penneru.* It is an erect shrub found throughout the drier parts of India, Baluchistan and Sri Lanka. It is described in the *Indian Pharmaceutial Codex* and included as a monograph in the *Indian Pharmacopoeia.* Two other species of *Withania* found in India are *W. coagulans* and *W. ashvagandha.*

The roots of Ashvagandha have been employed as a valuable drug in both Ayurveda and Unani systems of medicine. Punarvasu Atreya, who was a teacher in medicine at the University of Takshila in the Punjab (about 1000 B.C.), had described numerous uses of this drug. Charaka who lived later recommended it for hiccough and in female disorders. Bhavaprakasha had mentioned that "the drug checks *vatha, kapha,* leucoderma, dropsy, consumption and improves body strength as a bitter tonic and astringent; it is also known to stimulate sex impulses and improve sperms."

In Ayurveda the drug finds an important place in the treatment of rheumatic pain, inflammation of joints and in certain paralytic conditions. A number of proprietary preparations for some types of nervous disorders and as sedative in the treatment of insanity and hypertension are available. It is also used as a tonic for old people, relieving their limb tremors and prescribed as an aphrodisiac and for rejuvenation. Besides the roots of this plant, its leaves also have found application in all types of skin lesions, ulcers and boils and in reducing pus formation and inflammation. The Telugu saying "Peruleni vyadhiki Penneru gadda" which means 'for nameless disease, give Ashvagandha' appears very significant.

The drug is used in its powder form, in a dose of 20-60 grains mixed with sugar and ghee or milk and as a decoction; the powder in a capsule is convenient to take.

The chemical constituents of the drug have been studied in the past sixtyfive years. In 1911, F. B. Power and A. H. Salway (The Wellcome Chemical Research Laboratory, U.S.A., *Trans. Chem. Soc.*, **99**, 490) studied the roots of Ashvagandha of South African origin and isolated an amorphous alkaloid with no marked physiological activity. About twenty years later D. N. Majumdar and P. C. Guha (Indian Institute of Science, Bangalore, *J. Ind. Inst. Sci.*, 1933, **6A**, 29) reinvestigated the drug from a Bengal source to confirm the presence of alkaloids. In 1955, D. N. Majumdar (Dept. of Pharmaceutics, Benaras Hindu University, Varanasi, *Ind. J. Pharm.*, 1955, **17**, 158) reported isolation of eight brown alkaloids, observing that the major alkaloid 'withanine' showed marked sedative and hypnotic action. About five years later, C.L. Malhotra and coworkers (Dept. of Pharmacology, Lady Hardinge Medical College, New Delhi, *Ind. J. Med. Res.*, 1961, **49**, 448 and *J. Pharm. Sciences*, 1961, **50**, 876), showed that the total extract of the drug exhibited significant sedative action, and a relaxant and antispasmodic action on the ileal and tracheal muscles. It was also recorded that the drug could potentiate the action of phenobarbitone. During 1963, A. E. Schwarting and collaborators (Deptt. of Pharmacognosy, University of Connecticut, Storrs, U.S.A., *Llyodia*, 1963, **28**, 44 and earlier references cited therein) described over ten alkaloids; some of them fully characterised chemically as hygrine, cuscohygrine, anahygrine, anaferine and withasomnines. In 1956, P. A. Kurup (Central Institute of Research in Indigenous Systems of Medicine, Jamnagar, *Curr. Sci.*, 1956, **25**, 57 and *Antibiotics and Chemotherapy*, 1958, **8**, 511) isolated a crystalline principle named 'withaferin A' from the leaves of Ashvagandha and reported its significant antibiotic properties.

During the past decade, intensive work by groups of researchers under the leadership of S. Morris Kupchan, University of Wisconsin, Madison, U.S.A. (now at the University of Virginia, Charlottesville); Rudolf Tschesche, Institute of Organic and Biochemistry, University of Bonn, Germany; D. Lavie, the Weizmann Institute of Science and E. Glotter, the Hebrew University of Jerusalem, both of Rehovot, Israel and S. Sankara Subramanian at the Jawaharlal Institute of Post-Graduate Medical Education and Research, Pondicherry, has brought to light the occurrence of a number of substances related to withaferin A, and they have been shown to be compounds having steroidal structure similar to cortisone. More than forty compounds are now known in this and certain other Solanaceous plants, and are grouped as "Withanolides".

Withanolides are a new type of interesting C_{28} polyfunctional steroidal derivatives and possess an ergostane skeleton with a six-membered ring 22-hydroxy-26-oic acid lactone; their stereochemistry has much significance in their biological activity.

Withaferin A, the first withanolide to be described, has its chemical structure as 4β, 27-dihydroxy-5β, 6β-epoxy-l-oxo-22R-witha-2,24dienolide and possesses antibacterial, antitumour, anti-inflammatory and antiarthritic properties. This justifies the significant use of Ashvagandha in Indian medicine (P. D. Sethi, A. R. Thyagarajan and S. Sankara Subramanian, *Ind. J. Pharmacol.*, 1970, **2**, 165 & 1972, **4**, 30). Alongwith withaferin A, more than ten closely related steroidal lactones have been reported as minor components from the leaves of chemotype I, II and III of *W. somnifera* (A. Abraham *et al., Phytochem.*, 1975, **14**, 189-194).

Withanolides are also found in other genera of the Solanaceae such as *Physalis*, *Acnistus* and *Jaborosa*. 4β-hydroxy withanolide E from the leaves of *Physalis peruviana*, grown in India for its edible fruits, has been found to be three times as active as hydrocortisone for its anti-inflammatory and antiarthritic properties.

In the near future, this drug with steroidal lactones may find appreciation by allopathic doctors also. Like Sarpagandha (*Rauwolfia serpentina*), Ashvagandha has a bright future.

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Chloroplasts in capsules

PHOTOSYNTHETIC processes are normally studied by using isolated leaf cells, chloroplasts and sub-chloroplast particles. However, it has been a difficult task for plant physiologists to retain the activity of these experimental materials even under the most controlled conditions. In other words, these experimental materials (say chloroplasts) have to be used for experimental analysis soon after their isolation and on further storage they are always bound to lose their stability and hence their photosynthetic activity. No suitable procedure was available to maintain the stability of these materials under stored conditions for a long time. Kitajima and Warren L. Butler of the Department of Biology, University of California, USA in a recent paper (*Plant Physiology*, 1976, **57**, 746-750) describe an elegant, method of isolating chloroplast fragments and encapsulating them with an artificial membrane built by cross-linking protamine with toluene diisocyanate (TDI). The capsulated chloroplast particles have been shown to be physiologically active for weeks together in stored conditions.

The procedure of encapsulation is not laborious. A mixture of 1 ml of 10% gelatin and 4 ml of 40% solution of protamine maintained at pH 8 is warmed to give a clear solution and recooled at room temperature. 5 ml of chloroplast suspension containing about 1 mg/ml chlorophyll in a buffer is added to the gelatin-protamine solution by constant stirring. The chloroplast-protamine-gelatin mixture is then added to 100 ml of dibutylphthalate (DBP) in a 200 ml stainless steel beaker kept in a water bath. The contents of the beaker are stirred with powerful stirring blade whose edges are sharpened to increase sheer. By controlling the speed of the stirring motor, droplets of desired size can be got. The emuslion is cooled to about 5°C by adding ice to the water bath. After 10 minutes of constant stirring to establish a stable emulsion, 5 ml of TDI dissolved in DBP is added and stirring is continued in the ice

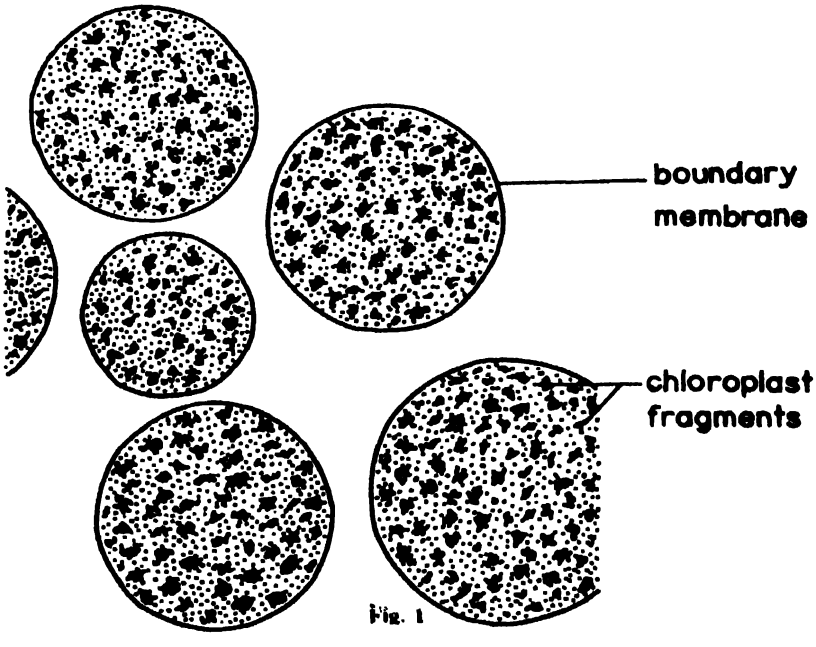

Fig. 1

bath for further 10 to 15 hours. Under these experimental conditions, the TDI cross-links amino-groups of the protamine and slowly builds up a polymer membrane at the emulsion interface. This results in the formation of capsules containing sheared chloroplasts and can be recovered from DBP by petroleum ether treatment and centrifugation. The pellet fraction is dispersed in glycerol and spun again at 1000g for 10 minutes. Among the three layers, viz., upper organic phase, middle green capsules, bottom glycerol formed, the middle layer containing the capsules can be easily transferred to a suitable buffer and used for photosynthetic studies.

Characteristics of the capsules

Light microscopic observations (Fig. 1) show the capsules to be uniform green spheres ranging in diameter from 10 μm to 50 μm. Numerous chloroplast fragments could be seen within the polymer membrane. Electron microscopy reveals each capsule to be a single boundary membrane. The encapsulated chloroplast fragments are found to be physiologically active and retain the photosystem I activity of methyl viologen-mediated oxygen uptake using ascorbate and DPIP couple as electron donor over a period of 4 weeks in refrigerator. Apart from chloroplasts, microencapsulation of PS I particles with soluble proteins and also with the enzyme hydrogenase prepared from the bacterium *Chromatium vinosum* have also been successfully made.

The encapsulation method has several advantages which are otherwise not possible in the already available procedures. The photochemical apparatus of the chloroplast fragments appears to be quite stable since it is free from proteinases and other catabolic enzymes and also from bacteria. It further keeps the photosynthetic apparatus in close contact with the selected electron transport enzymes. The artificial membrane is permeable only to small substrate and product molecules and not to soluble proteins. Maintenance of soluble proteins at relatively higher concentrations away from the action of degradative enzymes, naturally enhances the stability of these proteins playing definite roles in photosynthetic processes.

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What is a red tide?

It is very interesting to note that the phytoplankton (*Phytos*—plant; *Plankton*—wanderer, small microscopic plant organisms) of the oceans have the unique capacity to reproduce if the conditions are congenial. If the nutrients are sufficient, light conditions optimum for photosynthesis and oxygen is available in sufficient quantities, the multiplication of these cells is so extensive that large numbers emerge covering the surface of the waters. As the density of the population increases the available nutrients decrease. Due to lack of nutrients they begin to disintegrate faster than the rate at which they multiplied. The multitude of the plankton organisms discolours the waters very often to the virtual exclusion of other organisms. This discolouration due to multiplication of a single species is known as "water blooms."

These blooms have shades between red, brown, yellow and green, and are known as "Red tides." Dinoflagellates, a group of phytoplankton, are mostly responsible for the red tide phenomenon. The blooms may cause great destruction to invertebrate animals and fishes. Most oceanic dinoflagellates are found at depths of less than 50 metres. Estuarine (the organisms in an estuary—where the river water mixes with the sea) and neritic forms (the organisms which are found upto a depth of less than 200 meters) need less depth than the oceanic forms (found beyond 200 meters). The salinity tolerance largely determines the distribution of the dinoflagellates as estuarine, neritic and oceanic forms. In neritic and estuarine areas salinity varies greatly because of the influence of land drainage.

Fluctuation in the abundance of dinoflagellates in the sea reflects changes in environment and to some extent the rate at which the zooplankton (microscopic animals) consume the dinoflagellates (phytoplankton). Usually blooms of dinoflagellates follow blooms of diatoms (unicellular plant organisms). Abnormally high concentrations of phytoplankton per unit volume of water are called a bloom.

The normal concentration of diurnal period plankton cells are about 1000/litre and it is lethal when the count reaches several million cells/litre. In 1957 in Tampa Bay, Florida (USA), as high as 100,000,000 cells/litre were noticed. The colour of the sea water remains unchanged at a density of 250,000 cells/litre. If the concentration exceeds this limit and reaches several million cells/litre water becomes visibly discoloured. The outbreak of the red tides are generally classified into two categories; one, minor outbreaks which affect restricted localities such as a bay or an area limited to a few square km, for a short time (for a few days to a few weeks) and are non-toxic; second, major outbreaks covering large areas and

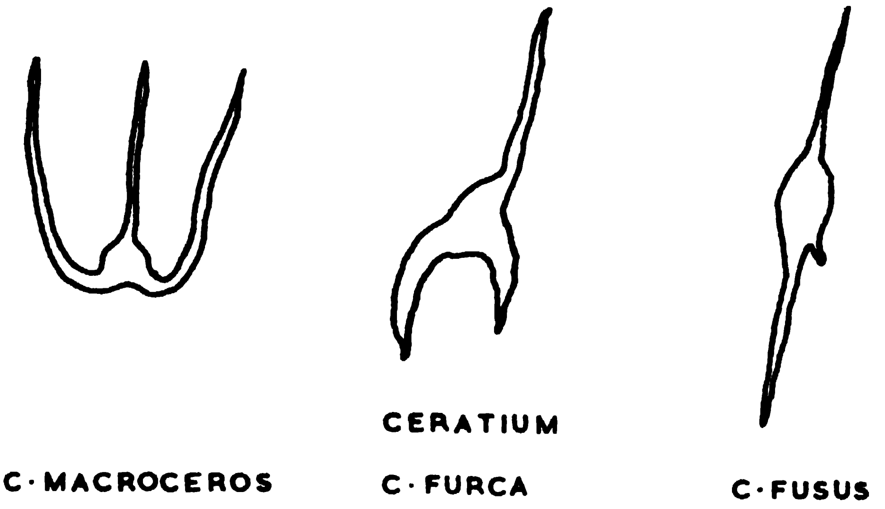

Fig. 1. Three different species of *ceratium*

exist for several weeks causing major devastation of the marine populations. These blooms are not always the cause of mortality of marine organisms.

The oldest report about the red tide phenomenon dates back to 1500 B.C. which blames dinoflagellates as most responsible for red tides. Discolouration is sometimes caused by non-toxic dinoflagellate blooms. Mass mortalities of marine organisms due to dinoflagellate blooms is due to the depletion of oxygen. There have been reports of occurrence of red tides in the Malabar coast, South-West African coast, Japan, south California and Gulf of Mexico. Bottom fish are the first to die due to these blooms and then the pelagic fish, Grunts, porcupine, snake eels, cat fish, bat fish and mullets were the common victims of *Gymnodinium breve*. Enormous quantities of dead fish are washed ashore to cover much as 52.5/front metre of the beach. Gymnodinium red tide is a menace not only to fish but also to barnacles, oysters, shrimps, clams, crabs, porpoises and turtles. Sea gulls and pelicans die after eating fish killed by red tide. Red tide gas produced by the decaying fish that litter the beaches cause hay fever, spasmic coughing, irritation of mucous membrane of the eyes and nostrils and breathing difficulties.

Red tides in Indian waters are not uncommon. Their blooms have been observed both in the east and west coasts of peninsular India. The red water phenomenon on Indian waters has been due to *Trichodesmium erythraeum* and there are reports of their occurrence in Pamban area in the east coast in the Gulf of Mannar during the month of April, May, July, October and November. These blooms had been found to exist from 3 to 7 days. In Porto Novo (11 29' N—29 49' E) waters in Bay of Bengal on the east coast of India the blooms due to *T. erythraeum* occurred annually during March from 1964 to 1970.

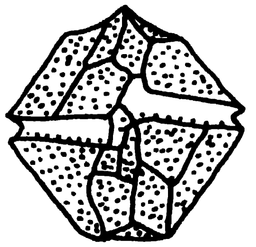

Fig. 2. *Gonyaulase polyedra*

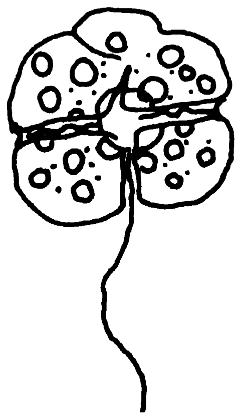

Fig. 3. *Gymnodinium breve*, **a dinoflagellate**

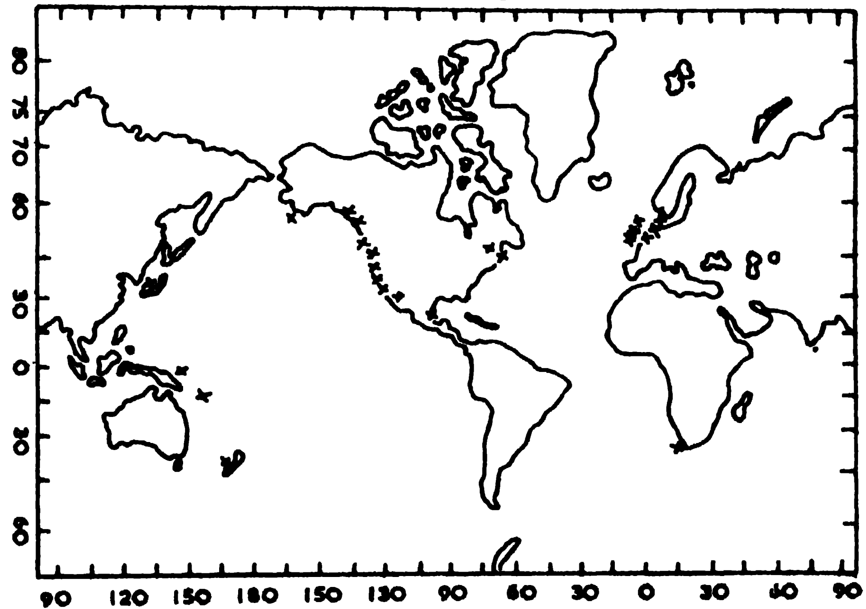

Fig. 4. The world distribution of paalytic shellfish poisoning due to outbreaks of red tide

The blooms were found to occur in a stretch of about 6 to 25 meters in width and extended up to 12 to 48 km (9.7 to 23.97 nautical miles). These blooms appeared between 7 to 15 fathom lines. The colour of the bloom was found to be gray with some pink-to-light red patches. Such blooms also appear on the Mangalore coast and around Laccadive Islands. Though there are reports of their occurrence on either sides of coastal India there is no report of their toxic effects or any report on significant mortality of fish or other marine life.

Further reading

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2. Firth, F. E. (Ed.) (1969), *The Encylopedia of Marine resources*, Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London.

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Magnetic fields in human body

ABOUT two hundred years ago the people of France believed in the cure of diseases with the application of magnetic fields to their bodies. This was due to Dr. Mesmer who preached that magnetism of the human body controlled the flow of a universal fluid through the body and that when the flow of the liquid was obstructed due to some reason illness followed. The illness would be cured by magnetically redirecting the fluid. For this purpose, the people of France sat in a group around a tub containing 'mesmerized' water and iron filings.

Today, two hundred years later, we know that the human body is really magnetic in the sense that the body is a source of magnetic field, but the magnetism is quite different from that imagined by Dr. Mesmer. Today's scientists, physiologists, and medical specialists believe that body magnetism may be medically useful—but the procedure involved is quite different from that practiced by the people of France. They do not believe in guiding any fluid through the body, but attempt to measure the magnetic fields produced by the human body and to interpret them.

In some cases, such as injury, some excitable tissues generate steady ion currents. An important case is heart when it is deprived of its blood supply. Steady ion-current is generated in the abdomen after drinking cold water. These steady currents produce steady magnetic fields.

Measurements

Body's magnetic fields produced by any mechanism discussed above are very weak. Fluctuating magnetic fields are produced by all the organs in the body that consist of or contain muscles and nerves. The strongest fluctuating magnetic field is produced by heart. The peak value of the field is somewhat greater than 10^6 gauss in normal subjects. The fields may be larger for some abnormal subjects. Some muscles, when flexed, produce high frequency magnetic fields whose peak value is 10^7 gauss. The strongest magnetic field from the nerve tissue is from brain. A normal brain produces its largest fields during sleep. It has an amplitude of 3×10^8 gauss. Epilepsy can produce much larger fields. The magnetic fields produced in the body are very weak in compari-

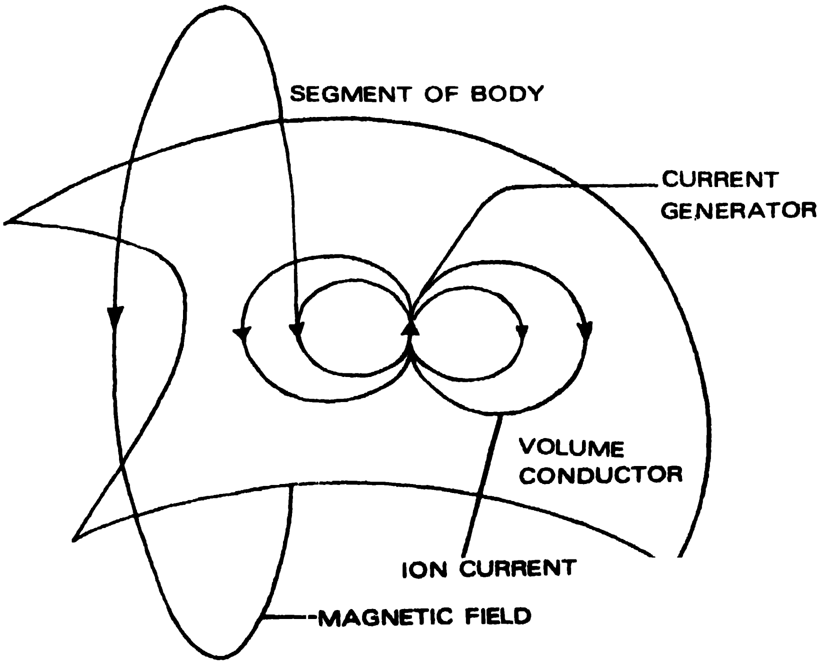


Fig. 1. Mechanism of production of magnetic field in he human body

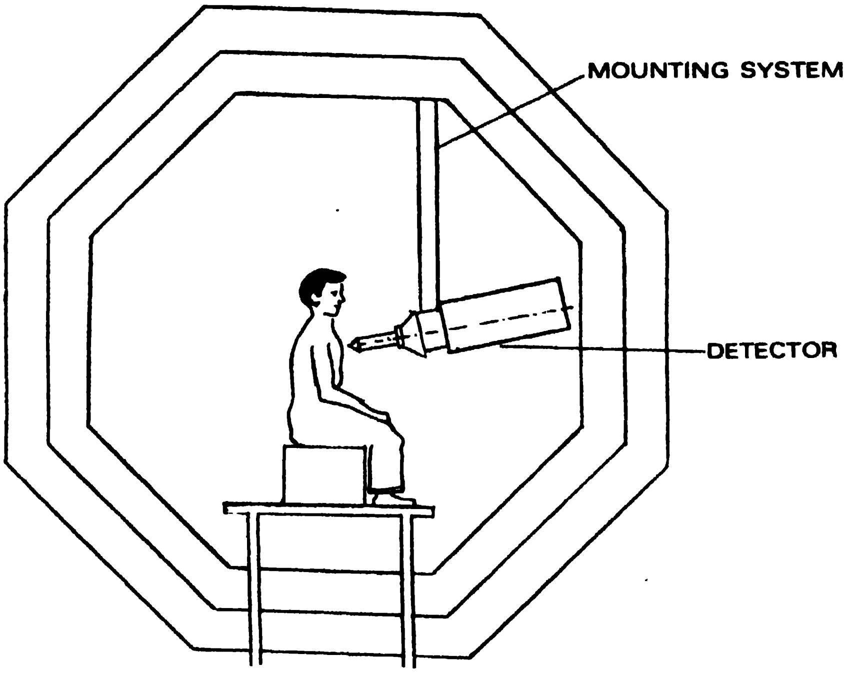


Fig. 2. Measurement of the magnetic field of the heart using a shielded room

son to the fluctuating component of the magnetic background which is several milligauss in an urban environment due to rotating machinary, alternating currents, and moving vehicles. The fluctuating background in a rural environment, though considerably less, is still much greater than the body's fluctuating magnetic fields. The fluctuating magnetic field of the body is to be measured in a background which is much greater than the field to be measured.

The same is the case of steady magnetic fields. Because the strength of earth's steady magnetic field is about 0.5 gauss, the steady fields from the body are to be measured in a steady background that is greater by 4 or more orders of magnitude. We see that the major problem in measuring the body's magnetic field is the presence of a large background.

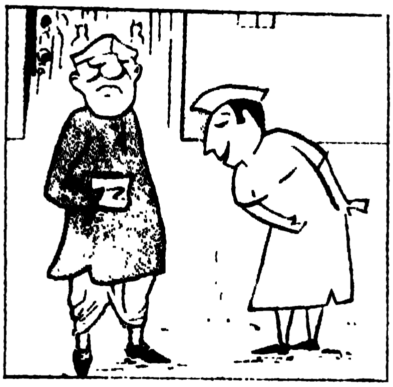
Mechanisms

A question naturally arises: How are magnetic fields of the body produced? There are two different mechanisms.

(1) First, magnetic fields are produced by electric currents present inside the body due to sodium, potassium and chlorine ions that the excitable tissues (i.e., nerves and muscles) generate in the process of contraction or signal transmission. The currents flow through the general mass of fluids and tissues of the body called the 'volume conductor'. They may be fluctuating (a.c.) and thereby produce fluctuating magnetic fields, or may be steady (d.c.), producing steady magnetic fields. The mechanism is illustrated in Fig.1; the generator of current in the tissue is represented in the simplest way by a current dipole (the current dipole is the current analogue of the charge dipole.). It is well-known that heart and brain generate ion currents. The current from the heart muscle, when measured with electrodes on the skin, gives electrocardiogram (ECG). The magnetic field around the torso produced by this current, when measured, gives the magnet-ocardiogram (MCG). The current from brain gives electro-encephalogram (EEG) at the scalp and also produces a magnetic field around the head which, when measured, gives the magnetoencephlogram (MEG). As blood is electrically neutral, there is no current associated with the blood flow and hence no magnetic field.

(2) The other reason for the production of the body's magnetic field is the presence of magnetic materials in the body. In general, magnetic materials produce magnetic fields when subjected to a magnetic field. We confine our attention to ferromagnetic substances only and will deal with their remnant fields after the removal of the applied magnetic field. These particles do not occur naturally in the body but are contaminants.

The first measurement of a magnetic field from human body was of the magnetic field produced by the heart. The detectors used consisted of two identical coils, each containing millions of turns around a heavy ferrite rod. They were placed parallel to each other on the subject's



"That is why I always describe you in all public meetings as a magnetic personality"

chest and were connected in opposition in order to largely cancel the background fluctuations. The induced voltages from a distant background disturbance would presumably be identical in the two coils, hence they would be cancelled. On the other hand, the heart's field, because of its gradient, would produce a net measurable voltage. The inherent coil noise and the problem of balancing the two coils exactly against the background are the main defects of this method.

David Cohen of the Massachusetts Institute of Technology used a different approach in dealing with the magnetic background. He and his colleague Lester Wingsberg constructed a magnetically shielded room. When a technique was employed to increase the permeability of the shielding layers, the room was effective in reducing the background, often below detectibility. The detector was a single coil which measured one component of the field instead of the gradient. This system readily gave the heart's signal and also the fields from other organs.

Later, D. Cohen and coworkers constructed at the Massachusetts Institute of Technology, a heavily shielded room that reduced the background much further. A newly developed super-conducting quantum interference device (SQID) magnetometer was installed in the room. It measured the heart's magnetic field with greater clarity and sensitivity than was previously possible. Its frequency response was from d.c. to 500 Hz. The r.m.s. value of the internal detector noise, which defines the limit of sensitivity, is about 1.6×10^{-10} gauss Hz$^{-\frac{1}{2}}$ and is low enough to allow measurement of all the body's fields except the weaker ones from the brain.

Although a body's magnetic fields can be measured more accurately by the SQID, one-component magnetometer, gradiometers are now being used because of their advantage that they can be used with little or no shielding. They consist of two or more magnetometers that are oriented largely to cancel the background.

Magnetic field of the heart

Magnetic fields from the heart have been measured to a larger extent than from any other part or organ of the body. This is because heart's magnetic field is relatively large and therefore can be measured with greater accuracy. Much is already known about the electrical activity of the heart, and there is a possibility that new diagnostic techniques may be developed that may save many lives.

MCGs are classified as d.c. MCG and a.c. MCG. The magnetic fields from the heart having frequency greater than 40 Hz give the a.c. MCG and those having frequency in the range d c. to 40 Hz give the d.c. MCG.

a.c. MCG maps have been recorded for many normal and abnormal heart subjects as a part of a programme to obtain the new fundamental or diagnostic information in the MCG that is not available in the ECG.

The d.c. MCGs are used to investigate heart when it is injured by the curtailment of blood supply. It generates a steady injury current. Ischemia is the associated condition in which blood supply to heart is diminished. It can lead to angina or infarction. This current is interrupted for a short period in each heart cycle and therefore has an a.c. component which makes it detectable on the ECG. This a.c. component is important in the diagnosis of angina and infarction.

Magnetic field of the brain

Due to various reasons, EEGs give relatively less information of the brain than the ECGs give about the heart. Hence MEGs have more general applications to the brain than that of the MCG for the heart.

MEGs are useful in determining steady currents in the brain. It is very difficult to measure steady brain currents with surface electrodes because of electrode-skin potentials, but magnetic determination of the steady currents is free of such potentials.

Magnetic fields of lung and other organs

In mapping steady magnetic fields produced by the natural, internal d.c. around the torso Cohen noticed that often there was another steady field that was not due to internal d.c. Investigation showed that this field was produced by ferromagnetic particles in the lungs, stomach and other organs. These particles are foreign to the body and are called ferromagnetic contaminants (FC). It was suggested that magnetic measurement of FC in the human lungs may be medically useful.

Reasons for measuring fields

We have seen that measurement of a body's magnetic fields is very difficult. A question, therefore, arises: Why then should we measure these fields?

The first advantage is that the measurement of the body's magnetic field gives some information about the organs of the body that cannot be obtained by potential measurements on the skin, particularly in lungs and brain. Body's magnetic fields are measured for medical diagnosis to find the level of harmful substances present in the lungs for physiological research, etc., One consideration in determining their clinical usefulness is the ease with which these measurements can be made. From this point of view measurements of the magnetic field of the lungs have the greatest potential. Next are the MCGs.

Measurement of Fe_3O_4 particles in the lungs is useful for two reasons. First is the determination of the amount of asbestos present in the lungs, because it is now well-known that asbestos dust that has settled in the lungs, when present in large amounts, has harmful effects. Nearly all asbestos is strongly ferromagnetic and can therefore be detected. The ferromagnetism of asbestos is not an intrinsic property; it is due to the trace of Fe_3O_4 particles that adhere to the asbestos fibres. Sometimes the deposit of asbestos in the lungs can be detected with the fluxgate gradiometer before an X-ray can show it. If the ratio of magnetite to asbestos is known for the inhaled dust, the amount of asbestos present in the lungs can roughly be determined by a fluxgate gradiometer. Cohen believes that this technique will be useful to the asbestos mining industry, where the ratio of magnetite to asbestos is large.

The second use of magnetite in the lungs is as a harmless tracer in determining rates of lung clearance and other processes. Disease in the lungs often develops to a serious stage before it can be detected. Use of magnetite as a tracer substance in the lungs is of diagnostic value. It may be mentioned that pure magnetite dust is harmless in lungs even in gramme amounts.

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'Pace-maker' cells in brain regulate aging

APPARENTLY much progress has been made in gerontology in recent years, but little has been achieved by way of either extending the human life span or preventing the decline in vigour that accompanies aging. Investigators nonetheless are trying hard to understand the basic causes of aging. It remains almost as much a mystery today as ever.

The nervous system and the brain in particular are the primary sites to look for the origin of aging changes in the body. The brain acts as the regulating and co-ordinating centre for the different body processes. It also is the site of origin of several hormones, some of which are known to regulate aging in target organs. The study of aging in brain is interesting from another angle too. Unlike most other tissues in the body which can either periodically or continuously undergo cell division (intermitotics) brain is a fixed post mitotic tissue i.e. it loses its mitotic capacity early in life. Further growth in such cells can occur only by an increase in size. For example, the maximum number of nerve cells in human brain already obtains at the time of birth. There is little increase in its number afterwards. Such post-mitotic tissues as the brain and muscle are subjected to more intense aging changes than the continuously dividing cells like those of liver.

Not only the capacity to undergo cell division is limited in brain, there is also progressive loss of neurons from the brain. Horton Johnson and Stuart Erner (1972) of the Health Sciences Centre, State University of New York have reported that the number of 5.5 million neurons in the young mouse brain drops to its one third in extreme old age. From this they conclude that irreparable loss of cells to the most vital organ in the body is perhaps a factor in limiting life span. Recently, Kalidas Nandy and others of Emory University, Atlanta, Georgia have shown the presence of brain specific antibodies on mouse servum as a function of age which may account for such losses of neurons.

On the contrary, Caleb Finch (1972) of Cornell University Medical College and Leonard Franks of the Imperial Cancer Research Fund, London and others believe that the life-span is controlled by a small group of 'pace-maker' cells in the brain, changes initiated by these cells affect other target organs throughout the body via afferent nerves or through their influence on pituitary hormones. Loss of these essential cells could lead to the death of the individual.

Evidence for this in part has already been provided by Bernard Strehler (1975) of the Division of Biological Science, University of Southern California at Los Angeles who has observed loss of genes from selected areas in the brains of old beagle dogs with age.

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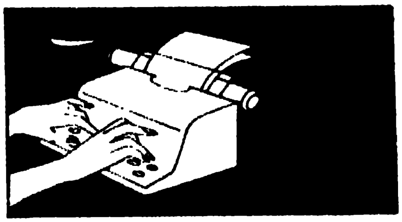

NEWS & NOTES

Prof. Ramachandran elected F.R.S.

PROF. G. N. Ramachandran, Professor of Bio-Physics at the Indian Institute of Science, Bangalore, has been elected Fellow of the Royal Society, London.

This award is the latest in the chain of several distinctions earned by Dr. Ramachandran for his significant contributions to the understanding of the structure of biological macromolecules. Dr. Ramachandran's main contribution has been the study of the structure of collagen which forms the essential constituent of connective tissues such as skin, tendon, bone, etc. Collagen accounts for more than half the proteins in the animal system.

His studies have revealed the exact role played by the amino acid, hydroxyproline, which occurs only in collagen and in no other protein, and whose role was not known previously. His team has attributed to hydroxyproline the role of interconnecting the three chains of the triple helix by means of hydrogen bonds. In addition, using the techniques developed for biopolymer analysis, his group has worked out a new method of solving crystal structures, namely, by packing the molecules in the known unit cell of the crystal and by checking that there are no short-contacts between each molecule and its neighbours.

The Department of Molecular Biophysics at the Indian Institute of Science was created by Dr. Ramachandran five years ago.

His initial work on the structure of collagen was done at the Department of Physics at the University of Madras.

Prof. Ramachandran

Professor Ramachandran is a graduate of the University of Madras from where he took his M. A. and M.Sc. degrees, after which he worked for his doctorate with Prof. Sir C. V. Raman at the Indian Institute of Science, Bangalore. In addition to the D.Sc. from Madras, he is also the recipient of Ph.D. from the University of Cambridge, England, where he worked under the celebrated discoverer of X-ray diffraction, Prof. Sir Lawrence Bragg. After returning to India in 1949 he was Assistant Professor at the Indian Institute of Science for three years, after which he was appointed Professor and Head of the Department of Physics at the University of Madras at the early age of 30.

An Interview

Prof. K.P. Sinha

"LIKE Max Born of Germany, J. Robert Oppenheimer of U.S.A., Lev Landau of Russia, Indian scientists should strive to build new Schools—and not new Institutes," says the eminent theoretical physicist Prof. Krityunjai Prasad Sinha, of Indian Institute of Science, Bangalore, the winner of the Bhatnagar Award in Physical Sciences for the year 1974. By new schools he means nurturing a group of students along a specific "style of thinking and research," so that they trigger a sort of chain reaction, attracting more students to their school and way of research.

Who could be more confident of talking about all this than Prof. Sinha? Apart from his notable contributions to physical chemistry, particle physics, gravity, cosmology and astrophysics, he has also produced some brilliant students in the country who are presently doing commendable research. And what is more interesting about him is that with almost every student he changes his research problem as well. The reasons? There are two.

Prof. Sinha

First, of course, is the interest of the student. His shifting from one subject to another with appreciable contributions in all becomes apparent when one comes to know that his students are not necessarily physicists. One, Dr. N. Kumar, for instance, who has done some brilliant work with him in superfluidity and superconductivity is an M. Tech. in microwave. On the other hand, C. Sivaram with whom he has done research in strong and weak gravity and its impact on astrophysics is basically a mechanical engineer.

Secondly, he changes his subject of research once he realises that he has done his best work in that field. His outstanding work in the last few years has been on the quantum theory of solid-solid interactions, phase transition in solids, mechanisms of exchange interactions in magnetic crystals, phonon-magnon and electron-magnon interactions and relaxation processes in para, ferro, ferri and antiferromagnetic solids, electron-phonon interactions and the transport properties of semiconductors, the origin of giant magnetic moments and resistance minimum phenomenon in dilute alloys, mechanisms of superconductivity, in particular, the development of the concept of nonequilibrium processes involving photon-induced superconductivity which shows great promise for getting room temperature superconductivity, non-radiative electron hole recombination processes, electronic phase transitions and exciton condensation. In recent years, Prof. Sinha has developed a new approach, involving general relativity and strong gravity, in the study of elementary particles and cosmological models.

But, how did he get interested in science? Prof. Sinha, on much persistence, said that popular science lectures given at his school had impressed him and coaxed him into taking science as a career. A few teachers, for example, Prof. G. I. Finch, a former Director of National Chemical Laboratory, Pune, and Prof. M. H. I. Pryce, of Bristol University, U.K., were also a source of inspiration for him.

Today, apart from being a visiting scientist to various foreign Institutes, Prof. Sinha has the distinction of being recognised as a brilliant physicist of the University of Bristol.

What is the secret behind his commendable research work? Besides hard work, Prof. Sinha claims that he takes "every student as a separate individual and his treatment varies from one to another." He believes in making the student interested in a problem first and then tackling it together.

DILIP M. SALWI

Phycologist R. N. Singh passes away

DR. Rama Nagina Singh, former Professor and Head of the Department of Botany, Banaras Hindu University and an internationally known Phycologist, died on March 9, 1977 in Varanasi. He was well known as a researcher in the field of Phycology. He was equally well known for his *Role of Blue-green Algae in the Nitrogen Economy of Indian Agriculture* published in 1961 by the Indian Council of Agricultural Research, New Delhi. His contributions to phycology started with systematics, autecology and limnology and turned through ultrastructure, physiology and biochemistry to the genetics of blue-green algae and their viruses. Prof. Singh had the opportunity of working in several foreign laboratories. His research publications with Prof. Hans Ris and R. H. Burris of the United States formed the pioneering reports on the ultrastructure and biochemistry of nitrogen-fixing blue-green algae. Genetical studies on blue-green algae, which started with his report in 1957 on an X-ray induced mutant, were finally given an orientation by him towards understanding of the possible relationship between nitrogen fixation and heterocyst differentiation in these organisms; the advantages they could provide in terms of genetic compatibility for their use as starting experimental organisms for physiologic/genetic transfer of the nitrogen fixation ability to otherwise distant taxa.

Born on August 8, 1915 at Deoria in U.P. in a zamindar family, Dr. Singh studied upto high school in Udai Pratap College, B.Sc. at Ewing Christian College, Allahabad University and obtained his M.Sc. and D.Sc. from Banaras Hindu University. He joined the Department of Botany, Banaras Hindu University, and served the University in various capacities. He retired as a Senior Professor and Head of the Department of Botany on August 8, 1976. Before his retirement, he was elected President of Botany section at 61th Indian Science Congress held at Nagpur in 1974. After his retirement he was devoting his entire time to completing the book entitled *The Algae* under the U.G.C. book writing scheme. He told me personally, two days before his death, that the writing work of the book was almost complete and was ready for the press.

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Drs. Yalow, Ahlquist, Black and WHO get Lasker Award

THE $10,000 Lasker Awards are among the most prestigious prizes in American medicine. Since 1945, when they were first awarded, a total of 25 Lasker awardees were later awarded Nobel Prizes. The 1976 Lasker Awards in Medicine have recently been awarded to Dr. Rosalyn S. Yalow who developed a new laboratory tool that has led to detection of many body metabolites and drugs; Dr. Raymond P. Ahlquist and Dr. James W. Black who developed a drug that is widely used in the treatment of heart disease and high blood pressure; and the World Health Organization (WHO) which has virtually eradicated smallpox in the world.

Dr. Yalow got the Lasker Basic Medical Research Award for her role in developing with late Dr. Solomon A. Berson the radioimmunoassay technique at the Bronx Veterans Administration Hospital in New York. This technique is now routinely used to measure concentrations in minute amounts of hundreds of metabolites, hormones, vitamins, viruses, enzymes, and drugs and to help determine changes between normal and diseased states. The radioimmunoassay that uses radio isotopes to measure the concentrations of various substances in a variety of body tissues and fluids is an application of nuclear physics to medicine. Dr. Yalow was the first woman and the first nuclear physicist to win the basic medical research award.

Dr. Ahlquist of the Medical College of Georgia in Augusta, and Dr. Black of the University of London, shared the Lasker Clinical Medical Research Award for their independent research that led to the development of a class of drugs called beta blockers. Propanolol, an example of this class, is used by thousands of people to prevent irregular heartbeats and to lower their blood pressure.

The WHO in Geneva received the rarely awarded Lasker Public Health Service Award for "the imminent eradication of smallpox—the first and only disease ever to be eradicated from the Earth." Now smallpox exists in just one country—Somalia. Health workers are trying to search every house in an effort to eradicate the last cases in Mogadishu, Somalian capital. Dr. Halfdan T. Mahler, a Danish physician who is Director-general of the WHO, and Dr. Donald A. Henderson, an American who is Director of the WHO's global smallpox eradication programme, accepted the Award for the WHO in a recent ceremony in New York when Mrs. Albert D. Lasker, President of the Albert and Mary Lasker Foundation, presented the awards.

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REINDEER ANTLERS (*Continued from page 370*)

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MEDICAL NOTES

All about smoking

NEUROLOGISTS rightly believe that smoking is one of the most dangerous hazards that mankind faces today. It not only damages brain and interferes with the chemical control of blood constituents, but also causes cancers of lip, tongue, lung, etc. and produces peptic ulcers. Nicotine, a major constituent of the smoked or unsmoked tobacco, in some individuals exerts an excitatory effect upon gastric secretion thereby releasing more of the gastric acid; the latter causing erosion and ulceration of the gastrointestinal tract. Smoking also aggravates hypertension, bronchial cough, Buerger's disease (clotting of blood in big arteries and veins of limb), and Raynaud's disease (bluish turning of the digits).

The relationship of cigarette smoking to lung cancer, and tobacco-chewing to mouth cancer are not well established. It has been predicted that for a man aged 40 who smokes 20 or more cigarettes per day, the risk of dying of lung cancer before the age of 80 is of the order of 8 chances in 100, and that this is between 7 and 30 times as high as the chance for a non-smoker. How tobacco and tobacco preparations caused cancer was hitherto not exactly known. The problem now appears to have been solved decisively. At the Naylor Dana Institute of Disease Prevention, New York, a subsidiary of American Health Foundation, Dr. Dietrich Hoffmann and his associates in 1974 have unambiguously identified N^1-nitroso-nornicotine which is a potential carcinogenic (cancer-producing) compound. The amount of this hazardous substance in common U.S. tobacco products is between 1.9 and 88.6 ppm (parts per million), one of the highest values of an environmental nitrosamine yet reported. The amount of this substance in food and drink rarely exceeds 0.1 ppm. N^1-nitroso-nornicotine is in fact the first example of a potential organic carcinogen isolated from tobacco. Previously the incidence of cancer of lungs and other respiratory organs in tobacco-addicted persons was credited to nicotine, a major constituent of tobacco smoke. The latter is also accompanied by several other harmful gaseous substances, such as hydrocyanic acid (HCN), pyridine bases, ammonia, carbon dioxide, carbon monoxide, organic acids, aldehydes, hydrocarbons, and "tobacco tar" and "tobacco resins." Many smokers inhale the tobacco smoke into their lungs, while others allow it to remain in the mouth and expel it through the nostrils and mouth. It is quite obvious that inhalation promotes the absorption of the cancer-causing compound N^1-nitroso-nornicotine; prolonged contact of this substance with the membranes of the lungs provide a direct opportunity for the development of cancer. Smokers are therefore warned to mend their smoking pattern, that they should not inhale cigarette smoke into their lungs, or if possible they must refrain from smoking too.

A similar study on the effect of smoking on longevity made by Dr. R. Pearl in 1938 involved 6913 men. The study revealed the following results which were both interesting and shocking : 50% of the heavy smokers were dead in 17.5 years after the starting age of 30 years; it was 26 years before 59% of the moderate smokers were dead; and it took 28 years before 50% of the non-smokers died. These findings even today stand unchallenged, and signalize a grave warning to heavy and chain-smokers. However, it is also true that habits and human behavioural patterns do not change merely by occasional publication of such scientific results and data. Moreover, there had been hitherto no practical way available to stop smoking.

Now the question is why do people smoke? Several hypotheses have been propounded for finding an answer to this intriguing question. It has now been proved, more or less conclusively, that people smoke because they need nicotine, a poisonous alkaloid and a major component of cigarette tobacco. This need is purely physiological. Under stress and strain, the smoker smokes a greater number of cigarettes, which suggests that the body actually demands more of this addictive alkaloid. Research workers in Sweden have demonstrated how nicotine acts ? It goes straight to the brain and stimulates it for about 5 minutes. In another 10 minutes the brain gets depleted of this drug as it is metabolized in the liver and kidneys, and then excreted through urine. Dr. J. H. Weatherby had demonstrated in 1942 that the smoking of one cigarette by a habitual smoker produced the following transient physiological changes in the body: (i) increase in cystolic blood pressure by 10 to 25 mm; (ii) acceleration of pulse by 5 to 20 beats per minute; and (iii) drop in skin temperature by 2°C to 5°C (in fingers) and 3°C to 7°C (in toes). The complete removal of nicotine from the cigarette is the only way to annihilate most of these and other deterimental effects of smoking.

Several attempts have been made in various parts of the world to save people from the harmful effects of smoking, but without much success. The "denicotinized" cigarettes, containing about 40% of the normal nicotine content, are now available in several European countries. Dr. L. B. Johnson in 1942 experimented with a series of smokers by giving them a hypodermic injection of pure nicotine instead of allowing them to smoke. Following nicotine injection, smokers felt quite pleasant, and found it as an adequate substitute for smoking. In some European nations, tablets containing chemicals which leave a bad taste in the mouth are available. This can obviously help break a smoker's habit provided he continues to take pills. Similarly, in Germany, chewinggums containing silver acetate (0.2 part), ammonium chloride (0.7 part) and enzyme cocarboxylase (0.003 part) have been manufactured which when chewed by smokers will produce a tendency to abandon the habit of smoking. The effect of nicotine has also been simulated by another harmless, incompletely or completely consumable chewing material containing sedative substances, e. g., hops extract (which contains 32% humulone and 45% lupulone) and stimulating substances e.g., cola extracts (containing 10% caffeine) (German Patent No. 1,901,277, August 6, 1970). Group therapy, and in certain cases psychotherapy have also been tried to stop smoking habit. Another reasonable solution is to develop a safe cigarette, actually an imitation of the latter. A non-tobacco fag with a little caffeine added for a kick is being tried in Britain. Two big companies—a chemical firm and a tobacco concern—are carrying out trials with a tabacco-less cigarette. If the trials succeed, some of the terrors of smoking can be eliminated. Recent intensive tests by an American psychologist on the link between smoker's urine and the frequency of smoking show that by modifying the pH (acidity) of the urine the number of cigarettes smoked may be reduced. It is suggested that if a smoker consumes alkaline salts (like sodium bicarbonate) and foods, the depletion rate of nicotine from the body is considerably reduced, and hence he can reduce smoking. In this way without smoking too much, the brain's requirements for nicotine are met, avoiding simultaneously the excess intake of dangerous constituents of cigarette (like tar). What is now desirable on the part of smokers ? They should start taking more of non-acidic and alkaline items of food.

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Vinylidine chloride causes kidney cancer

In a recent study, Dr. Cesare Maltoni at the Institute of Oncology in Bologna, Italy, exposed rats, hamsters, and mice to vinylidine chloride gas at much higher levels, starting at 10 parts per million for upto one year and found that kidney cancers developed in about 20 per cent of the male Swiss mice, but in none of the other animals. Three years ago, Dr. Maltoni's studies showed that viny chloride, another plastic chemical like vinylidine chloride, caused cancer in rats and mice. Shortly afterwards, vinyl chloride was pinpointed as the cause of a rare, fatal liver cancer in exposed factory workers. Vinylidine chloride is a gaseous chemical which, when polymerized with vinyl chloride, makes up flexible wrap. (Other packaged plastic wraps are made of polyethylene). The vinylidine choride-vinyl chloride copolymer, called 'saran' is used to wrap commercially prepared meats and cheeses. It is said that about one-third of the flexible plastic packaging for food in grocery stores is saran, representing an annual market of 150 to 200 million pounds of plastic. The finding of an Italian researcher that vinylidine products in some plastic food wraps can cause cancer in mice prompted cancer experts in several countries to alert the public and Government agencies to the needfor closer scrutiny of this chemical which is related to two other cancer causing chemicals, vinyl chloride and trichloroethylene. The U.S's Dow Chemical Company researchers say, however, that studies of foods wrapped in plastics made from vinylidine chloride show none of the chemical migrating from the wrapping to the food. They contended that the tests would have disclosed contamination if it exceeded 10 parts of vinylidine chloride in one billion parts of food.

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Ancient medicine in eye diseases

RASAUT is the Hindi name of the plant, *Berberis aristata*. The plant is described in the ancient Indian literature as useful in prevention and cure of eye diseases. The Ayurvedic Treatise strongly recommend prophylactic washing of the eyes every fifth, seventh or eighth night with dried, aqueous extract of the plant. The chief alkaloid of *B. agistata* is berberine.

Trachoma is an important disease affecting about 20-80 per cent of the population in many provinces in our country. The current therapy of trachoma involves the use of drugs like sulfonamides and antibiotics, which are however prolonged and expensive.

The first ever clinical application of pure berberine was made by R.L. Verma (*Indian Med Gaz*, 68, 122, 1933) who had applied it to chronic trachoma patients by interaconjunctival injections (injunction into the conjunctiva membrane of the eyes). He had found the drug highly effective. Some scientists at the All India Institute of Medical Sciences New Delhi, recently conducted experiments on this drug and have concluded that "berberine may prove a practical remedy for large scale use in trachoma patients" (*Indian J. Med. Res.* 8 August 1977).

Zaka Imam

SUPERHEAVY ELEMENTS *(Continued on page 363)*

Now a question arises : What will be the highest possible nuclear charge ? One line of thinking is that as the nuclear charge increases, size of the electronic shell closest to the nucleus decreases; and at Z-150 or so, size of this electronic orbital will be about the size of the nucleus so that element number 150 or like would be expected to be the last member of the Periodic Table. Scientists are quite hopeful to synthesise or discover newer elements particularly of the atomic numbers 110, 114, 118 and 126, but all these elements will be always in micro amounts and potentially unstable.

Further reading

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FOR HER

Contraceptives that kill sperms

IN 1960's there was wide spread use of oral contraceptives and intrauterine contraceptive devices. But in later years, in many parts of the world, people lost interest in local vaginal contraceptives. Again, in 1970's, an era of new methods of contraception started. Many new approaches were made which included methods like subdermal implants of long acting progestagens, post-coital drugs and pregnancy vaccines comprising of human chorionic gonadotrophin secreted by the chorionic layer of early human placenta. When analysed chemically the gonadotrophin was found to be composed of two chains of amino acids, α-and β-subunits. Antibodies raised against α-subunits were found to be inactive but antibodies against β-subunits were found to terminate pregnancy in the early parts of its development.

But none of the above methods is perfect, and all have some side effects. Under these circumstances, it is advisable to use old methods of contraception with some modifications. So, before someone desires to use vaginal contraceptives, the following important points need consideration.

Vaginal contraceptives are basically spermicidal in action and are divided into three groups: (i) vaginal contraceptives having surface active agents as chief ingredients; (ii) vaginal contraceptives having organometallic or bactericides as chemical constituents; and (iii) vaginal contraceptives composed of weak acids such as acetic, boric and tartaric acid in the formula.

Most popular among them are the surface active agents which are divided into anionic, non-ionic and cationic types. These agents probably attach themselves to sperms and check the utilization of oxygen and fructose by them. This results in the breaking up of the sperm wall, making sperms incapable for fertilization. The most common example of such an action is nonylphenoxy ethanol, or nonoxynol-9, which is generally used as the main chemical ingredient in about 80% of the vaginal creams. Organometallic compounds or bactericides include metallic salts like phenyl mercuric salts or quinine salts and other metallic salts. Probable mode of action of these salts is by breaking up the sulphide bonds or by stopping fructolysis, i.e., utilization of fructose by ejaculated spermatozoa. Weak acids are used in vaginal douches and vaginal foaming tablets which change the pH of the vaginal fluid. The change in pH makes life of viable sperms impossible.

These chemical ingredients cannot act independently, and need a media in which they may be incorporated. Vehicle of a vaginal spermicide has been assigned many roles. For example, it may not only act as a physical barrier but also prohibit sperm penetration into the cervical mucus and promote a longer exposure time to the spermicide.

If one is convinced that vaginal spermicides can be used for contraception, there are some important criteria for an ideal vaginal contraceptive. For example, (i) it should act rapidly and efficiently, (ii) it should kill or immobilise all sperms on contact, (iii) it must render the sperm incapable of fertilization, and (iv) on being absorbed from the vaginal epithelium into the blood vascular system it should not show any untoward action in the body; should not be irritating to the mucus membrane of the vaginal and penile surfaces, and also it must not have any adverse effect on the developing foetus (in case of pregnancy not having been detected.

Vaginal contraceptives available in the market in India and abroad are in the form of jelly, creams, foaming tablets, aerosol foam, soluble c-film, etc.

Foaming tablets consist of bicarbonate of soda and tartaric acid, and glycerine as base material. On coming in contact with vaginal secretions, carbon-dioxide is released giving a rich foam. Foam carries spermicide which disperses over the full vaginal surface killing sperm in minimum possible time.

Aerosal foam contains oil and water emulsions stored under gas pressure. The liquefied gas is released producing a lot of foam, and foam acts as a spermicide.

Soluble c-film consists of polyvinyl alcohol, glycerine and base carboxymethylcellulose or a rice paper to carry these above spermicides. When this paper-like material containing spermicide is exposed to vaginal secretions, it is dissolved in about 30 minutes. So, it is always inserted ½ an hour before coitus to have a desirable effect.

Orthogynol is the most preferred and popular jelly in foreign countries. Its composition is different from nonoxynol-9 which is widely used in creams like Antenin, Conceptrol, Dalf and Immolin.

Recently, the Central Drug Research Institute, Lucknow has formulated a vaginal cream containing saponins derived from *Sapindus mukorosii* (soop-nut), 'Ritha' fruits. It is hoped that this formulation will be cheap and effective.

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SCIENCE FOR THE YOUNG

Communication in animals

ANIMALS belonging to different species use the most noisy shows to make themselves understood. Mostly the message given by one species to another is a warning, so that theother species must stay out of its way or keep out of its private territory. Usually such a warning is backed up with punishing action, for example, the growl of a dog, whir of a rattle snake, etc.

A very interesting example–a blue jay, finding a great horned owl near its nest, goes for attack. The blue jay, who is much smaller could do no real harm to the immensely stronger owl. But in this case, the breakdown in communication works to the advantage of the jay. The owl does not have any natural enemy. So it is not able to reply the attack of the jay. The jay's behaviour confuses the owl and momentarily short-circuits the owl's normal predatory response without its knowledge. The owl grows uneasy. If it is bothered enough, it will retire and run away.

Postures and patterns

Human beings, besides being able to communicate through speech, also have expressive smiles, tears, attitudes of body and manual gestures. Man can communicate with all these signs without talking as people of different languages do. Similarly, many animals are capable of conveying a fantastic amount of information to their fellows without making any sound.

A goose or a hen, depends almost entirely on posture to express itself. Similarly, a fresh water fish of *Cichlid* family not only changes the position of fins to express various emotions but actually changes its colour and pattern as well.

Communication under water

When we just look at the sea, we think that the world below its surface is silent. But it is not so. Rather there are sounds of whistles, moans and chirps—much beyond the limits of human ears. In the sea, light is poor and visibility nil. Animals rely increasingly on sound as their need for communication increases. Fishes are relatively stupid and communicate only slightly, if at all. They "hear" through their bodies, have little sense of the direction of a sound and most of them are silent.

The whales, porpoises and dolphins are highly intelligent and lead complex social lives. As they are mammals, they also have ears which are basically similar to ours and their hearing is far keener. Their ability to determine the position of an object, such as a reef, without being able to see in the same way as the bat does by echo location—is an extraordinary feature. They are capable of communication through a wide variety of sounds.

Signals and responses

In the animal kingdom, much of the communication is simple and direct but in higher species it becomes more complex. Most of their actions take place automatically without thinking. It is so with amoeba or paramecium and to a lesser degree with man. For example, give a prick to a *Homo sapiens*, and he jumps. In the case of fiddler crab, the male is ready to have any mate just so long as it is a female of the same species. When sexually urged this male crab begins to wave its claw, a characteristic feature and the female, seeing it, automatically approaches.

When a young one of a bird feels hungry, it gapes. That is the only language it knows. The parent bird automatically responds and begins to stuff it with food.

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Interesting results in recreational mathematics

THE following two groups of numbers 0, 5, 5, 10 and 1, 2, 8, 9 have an interesting property that the sum, sum of squares and sum of cubes of one group equals the sum, sum of squares and sum of cubes respectively of the other group. Thus

$$0+5+5+10=1+2+8+9$$
$$0^2+5^2+5^2+10^2=1^2+2^2+8^2+9^2$$
$$0^3+5^3+5^3+10^3=1^3+2^3+8^3+9^3$$

It may be noted that the two groups of five numbers 1, 4, 12, 13, 20 and 2, 3, 10, 16, 19 have also the aforesaid property. In other words,

$$1+4+12+13+20=2+3+10+16+19$$
$$1^2+4^2+12^2+13^2+20^2=2^2+3^2+10^2+16^2+19^2$$
$$1^3+4^3+12^3+13^3+20^3=2^3+3^3+10^3+16^3+19^3$$

2. In the following results

$9+9=18, \quad 9\times 9=81$
$24+3=27, \quad 24\times 3=72$
$47+2=49, \quad 47\times 2=94$
$497+2=499, \quad 497\times 2=994$

it is seen that the product of two numbers is the same as their sum when the digits of the resulting products are written in reverse order.

3. In each of the three following additions, the interesting thing is that 4 digits only occur in different orders:

$$\begin{array}{rrr} 4671 & 2493 & 2853 \\ +1476 & +2439 & +2385 \\ \hline 6147 & 4932 & 5238 \\ +1467 & +4392 & +3285 \\ \hline 7614 & 9324 & 8523 \end{array}$$

4. Factorial of any number n is defind as $1\times 2\times 3\times 4 \ldots (n-1)\times n$ and is written as either $\angle n$ or $n!$ Thus

$1!=1=1$
$2!=1\times 2=2$
$3!=1\times 2\times 3=6$
$4!=1\times 2\times 3\times 4=24$
$5!=1\times 2\times 3\times 4\times 5=120$
$6!=1\times 2\times 3\times 4\times 5\times 6=720$
$7!=1\times 2\times 3\times 4\times 5\times 6\times 7=5040$
$8!=1\times 2\times 3\times 4\times 5\times 6\times 7\times 8=40320$

and so on for other numbers. The factorial of 0, i.e., 01 is taken as 1.

Now consider the number 145 The factorials of the digits composing the number are

$1!=1, 4!=24$ and $5!=120$

Adding up, $1!+4!+5!=1+24+120=145$ which is the same as the number itself. Likewise it will be seen that the same property holds for the numbers 1 and 2.

For,

$1!=1$
$2!=2$

The next number for which this property, namely, the factorials of the composing digits add up to the number itself holds is 40585:

For

$0!=1, 4!=24, 5!=120, 8!=40320$

Adding up $4!+0!+5!+8!+5!$ one gets the number 40585.

There is no other number with this property apart from the above four numbers 1, 2, 145 and 40585. This has been demonstrated with the assistance of a computer (*Mathematical Review*, April 1973, U.S.A).

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"I took mathematics as a recreation, Dad, but the results are far from interesting"

Smoke detector : how it works

WHEN you hear about fire at some place, you imagine a disastrous situation covered with smoke and flames. Loss can be saved to a great extent by the use of early fire alarm devices. Smoke detector is an indispensable gadget for every home and industrial complex. This device can avert fatal fires.

Fire process

Fire develops in the following four stages.

Incipient stage. The heat produces invisible tiny particles in the process of thermal decomposition.

Smouldering stage. The combustion increases the size and quantity of particles. The smoke is now visible.

Flame stage. The gases and particles produced in the process of thermal decomposition ignite themselves. The flame gradually builds up.

High heat stage. This follows immediately after the flame stage. The rapid expansion of flames causes damage to property.

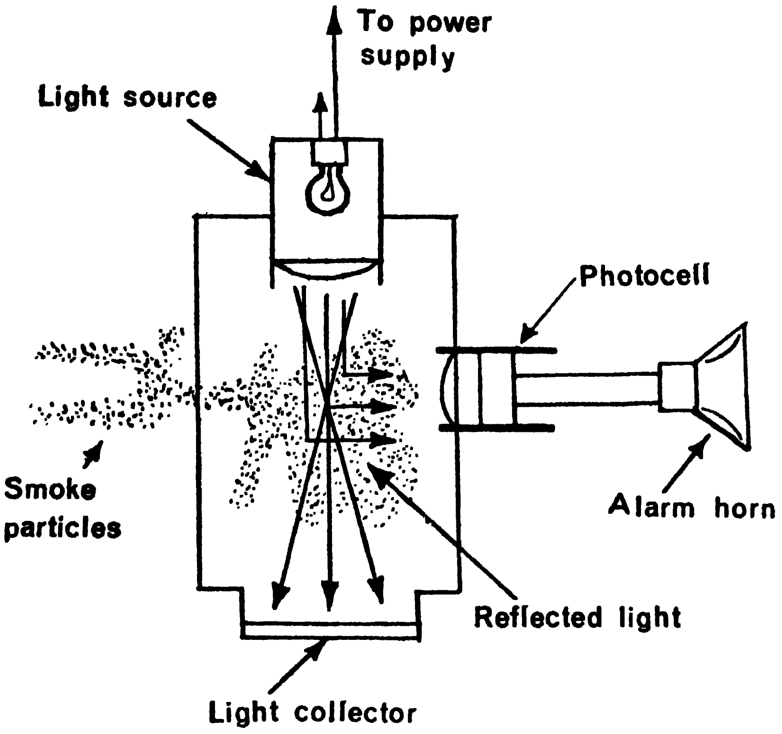

Fig. 1. Photocell type smoke detector

So fire can be detected by 'smoke' or 'heat' produced in the process. As the fire should be detected in the initial stage, smoke detectors are used. The smoke detectors help quicker control of fires.

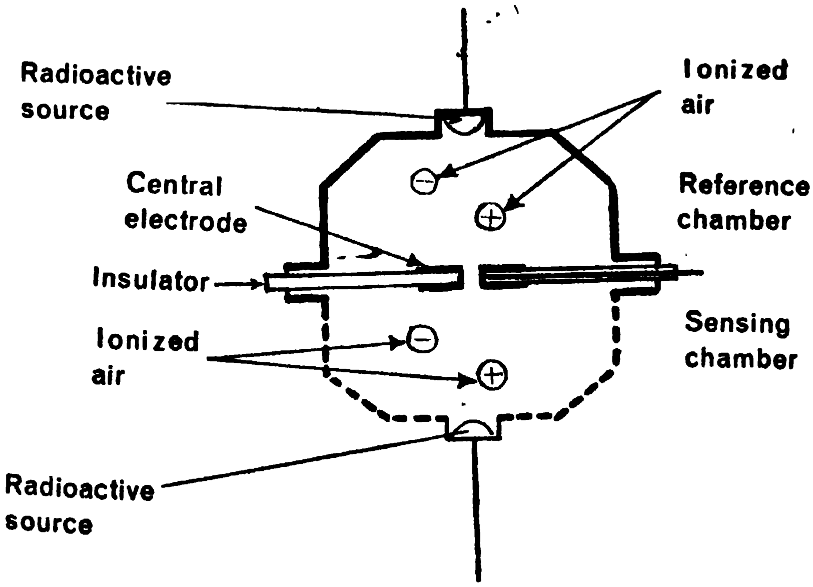

Fig. 2. Ionization type smoke detector

Operation of smoke detector

Two types of smoke detectors are available. The principle of operation is photoelectric principle or ionization principle.

Photoelectric type

The basic principle of operation in this type is scattering of light by smoke particles.

As shown in Fig. 1, such detectors consist of a light source (incandescent bulb or light-emitting diode), light collector or absorber, photocell for detection of smoke particles.

In the absence of fire the chamber is full of clean air. The beam of light travels across the chamber and is absorbed by a light absorber. The intensity of light in this case is insufficient to cause any change in photocell resistance.

In the case of fire, the smoke produced gets filled up inside the chamber. The small smoke particles scatter the light in all directions. A portion of the reflected light therefore falls on the photocell. The change in the resistance of the photocell is used to initiate an alarm by means of an electronic circuit.

Ionization type

In the ionization type of smoke detector, the smoke particles cause a decrease in the current resulting from the flow of ionized air.

The typical configuration of this type of detector is shown in Fig. 2. The electrodes in the center of the chamber cause ionization of air. These ionized air molecules travel across the chamber and produce a small ionization current.

When smoke enters the perforated chamber, the positive and negative ions now attach themselves to smoke particles. Since the smoke particles are larger than the size of air molecules, they travel very slowly across the chamber. This causes decrease in the ionization current. This decrease is used to initiate an alarm using an electronic circuit.

Both types of a smoke detectors are inexpensive lifesaving systems. They greatly enhance detection of fire in the early stage. It is observed that ionization type of smoke detectors are sensitive to flaming fires, while the photoelectric type of smoke detector reacts faster to smouldering fire. The photoelectric detector is therefore preferred for better early warning capability.

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Do it at home

Mini emergency light

YOU must have seen emergency light in theatres or cinema halls which glows when the mains supply goes off. The cheapest costs about Rs. 250/-. But the *mini emergency light* which could be made at home, will cost you Rs. 15/- only. Its construction is very simple. Fig. 1 represents the electronic circuit whose components are easily available. Fig. 2 shows a simple layout of components on a nine terminal strip. While assembling, the leads of the components can be identified as given bellow:

TR$_1$—PNP transistor AC125. It has three leads. The lead nearest to the dot mark on the case of the transistor is collector (C) the middle one is base (B) and the farthest is emitter (E).

TR$_2$—PNP transistor AC128. Identification of the leads same as in case of AC 125.

D$_1$—Diode EC051. The dot end indicates the cathode or the direction of arrow or diode BY125 whose rounded end indicates the cathode or the direction of the arrow.

R$_1$, R$_2$, R$_3$—Resistors are either marked with their values or with colour bands as given below :

R$_1$—33 Kohms—Orange/Orange/Orange—1 Watt

R$_2$—10 Kohms—Grey/Black/Orange—1 Watt.

-15 Kohms—Grey/Green/Orange—1/2 Watt

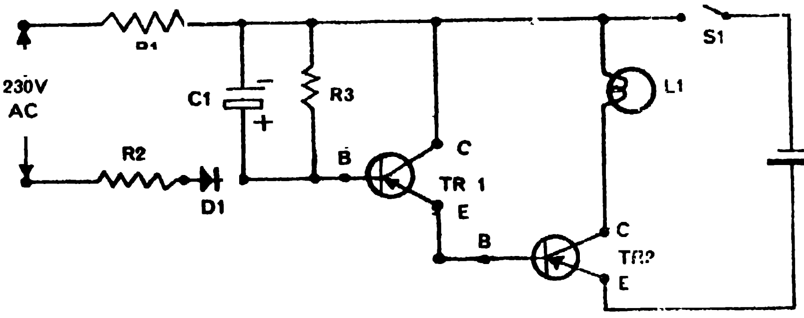

Fig. 1

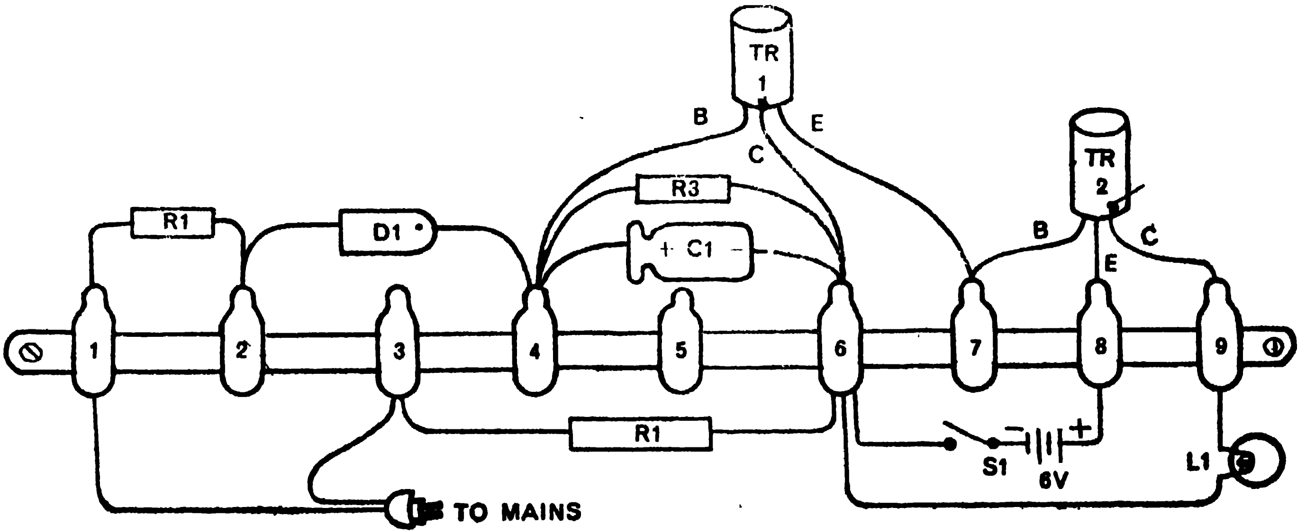

Fig. 2

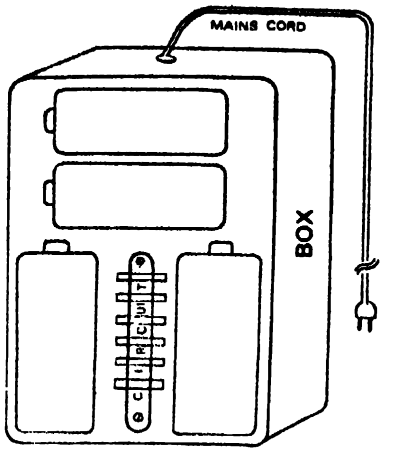

Fig. 3

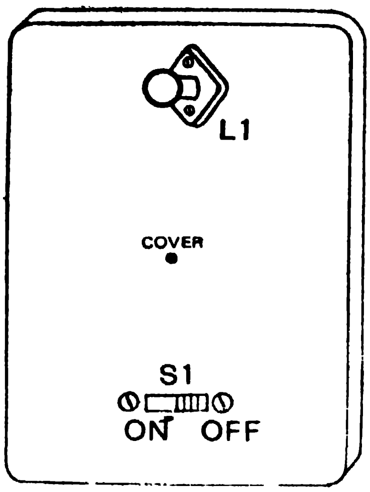

Fig. 4

These resistors can be connected either way.

S_1—Sliding switch. Single pole single throw.

L_1—Bulb 6 volts. 150 mAmps or 300 mAmps. Screw Type.

After assembling the components on the nine terminal strip, simply connect negative end of the 6 volts battery (4 cells of 1.5V in series) through the switch to terminal No. 6 and positive end directly to the terminal No. 8., the bulb should be connected across the terminal No. 6 and 9. After checking the connections thoroughly, switch on S_1, the bulb should glow. Then insert the mains plug in the 230V a.c. socket in your home. The bulb should go off. Now your circuit is ready for final assembly in a suitable box which can accommodate 4 cells and the circuit. Use a plastic box of dimension 18 cm × 15 cm × 5 cm with cover. Fig. 3 shows the arrangement of the cells and the circuit in the box. Fig. 4 shows the mounting of the bulb and the switch on the cover.

For wiring the bulb and switch, use a convenient length of wire, abcut 20 cm. Do not touch any point of the circuit when the unit is connected to 230V a.c. Switch off S_1 when you don't want the unit to work (i.e., during day-time).

How the circuit functions

The circuit works on the principle of Darlington Pair. Assuming the mains supply off and switch S_1 'on' (Fig. 1), the resistor R_2 biases the transistor TR_1 to conduct by making its base positive with respect to collector but negative with respect to emitter. As the emitter of TR_1 is connected to the base of transistor TR_2, the first drives the second into conduction and so current starts flowing through the collector causing the bulb L_1 to glow.

Now insert the mainsplug in 230V a.c. socket. Resistor R_1 and R_2 reduces the mains voltage to 6V a.c. which is then rectified and filtered by diode D_1 and capacitor C_1. This provides about positive 6 volts at the base of TR_1' making the base positive with respect to the emitter and so the transistor stops conducting. Simultaneously TR_2 also stops conducting, causing the bulb to go off as long as the mains supply is available.

When the mains supply goes off the bulb automatically starts glowing. Thus the circuit works as an emergency light.

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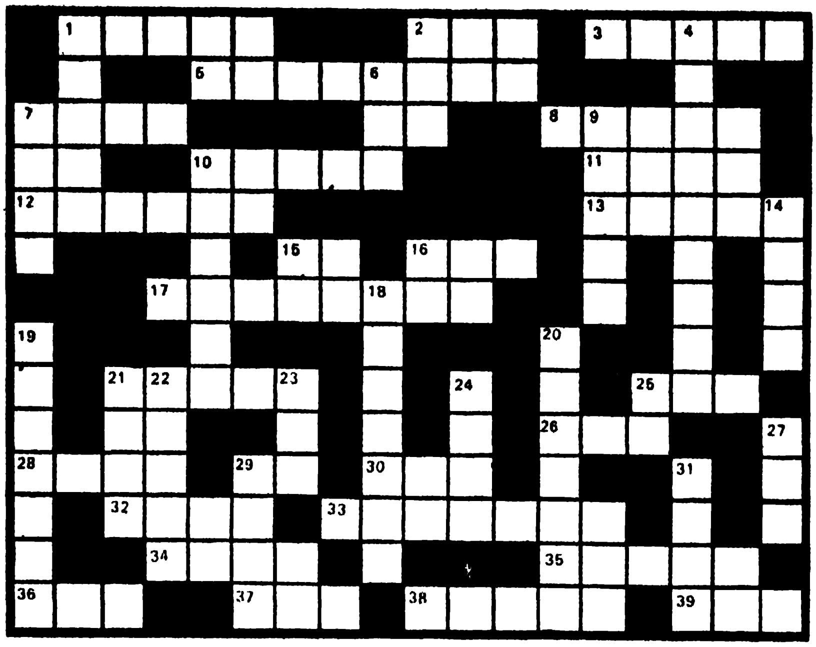
SCIENCE CROSSWORD PUZZLE



CLUES

Across

1. Decayed leaves and other organic debris.
2. After an - - - a large number of shells are exposed on the seashore.
3. Narcotic cocaine is obtained from this plant.
5. A skin disorder due to UV rays of the sun.
7. Seems like onion, but long instead of round.
8. Opium is extracted from this plant.
10. He found out a fossilised human skull.
11. Flesh of a pig.
12. He is called the Newton of Biology.
13. Tusk is of - - - - -.
15. Cloven-footed and horned farm animal.
16. A binocular, night bird of prey.
17. This is called the "Portuguese-man-of-war".
21. Means very old and gave origin to the word Gondwana.
25. See clue No. 2 Down.
26. A male sheep.
28. Protein, casein, is present in it.
30. Stomach of a cow.
32. Large diving bird with a wild cry.
33. This protein is in hair.
34. A land snail without a shell.
35. Fermented juice of palms.
36. Upper part of a pig's hind leg.
37. Juice of plants.
38. A part of the vascular tissue of an angiosperm.
39. A common deciduous forest

Down

1. Solitary cowardly animal that feeds on carrion.
2. A migratory fresh water fish.
4. Fossils of animal faeces.
6. "Make- - -while the sun shines."
7. Vein of ore.
9. A sedative narcotic extracted from poppy plants.
10. "The bread of Israelites"—small flowerless plants forming crust on rocks and trees.
14. Utter cry of a dog in anticipation.
18. A living fossil named after this lady biologist.
19. Ancestors of elephants, now extinct.
20. Members constituting the order Isoptera of class Insecta.
21. Large sea bird, white with black or grey markings.
22. A greek word that means abode.
23. Female of swine.
24. *Australopithecus sinanthrapus* was found in this land.
27. Young of a tiger.
28. *Bisan betvlaria*. is a - - - - -.
29. The end of the alimentary canal that excretes the bowels.
31. A flightless bird that has been exterminated by human intervention.

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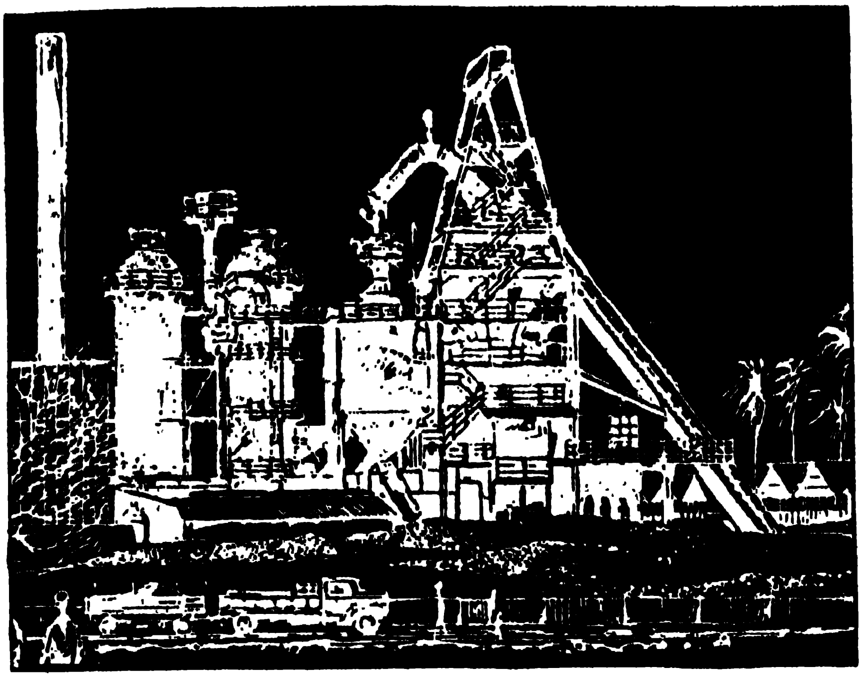
Centre of Advanced Studies in Marine Biology
Proto Novo-608502



SCIENCE IN INDUSTRY

New machines and tools developed by CMERI

DURING 1976, the Central Mechanical Engineering Research Institute, Durgapur concentrated its R&D efforts on development of products and processes suitable for adaptation in rural areas. Side by side, a few projects were undertaken for development of some industrial machinery with a view to import substitution.

Some of the projects relating to rural development which deserve special mention are : development of 10 HP tiller, development of deep well hand pump, utilisation of water hyacinth for gas production, development of smokeless domestic oven, and development of namda making machine.

Among industrial machinery, mention may be made of cable lapping machine and leather shaving machine.

10 HP tiller

The development of power tiller was taken to facililate Japanese method of cultivation in India. The tiller developed by CMERI has a 10 HP water cooled, light weight diesel engine. It has six forward and two reverse speeds. Tilling width is 54-60 cm and the average acreage tilled per day in 8 hours is 3.5 acres. The tiller is specially suitable for small land holdings and wet land cultivation.

Deep well hand pump

The project was jointly sponsored by WHO/UNICEF/Government of India with a view to evolve deep well hand pump suited for community use in rural areas and also to find ways and means of reducing the cost of the pump. The deep well hand pump, designed and developed by the Extension Centre of CMERI at Madras, makes extensive use of non-metallic raw materials, thereby minimising damage due to corrosion. Costly non-ferrous ma-

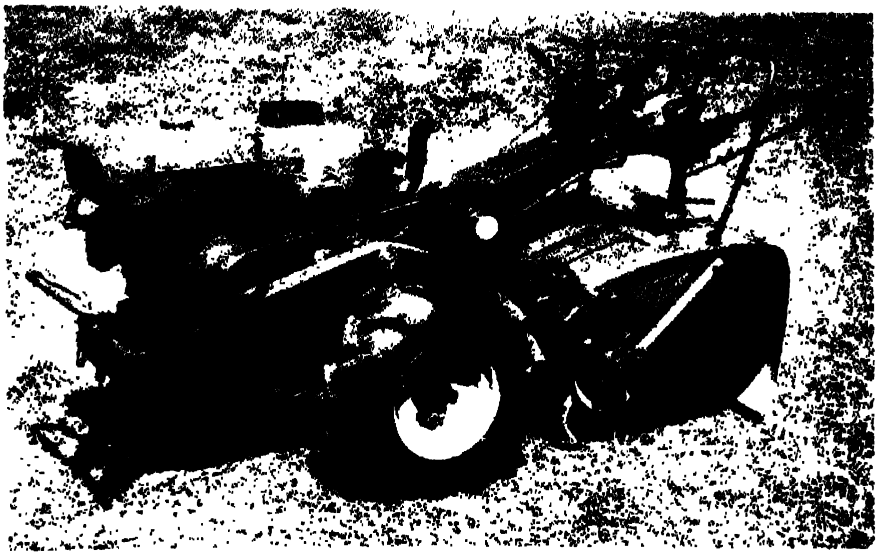


Fig 1. 10 HP agricultural tiller. It facilitates cultivation of small land holdings and wet lands

Fig. 2. Potato digger. It can conveniently be drawn by a tractor

terials have been eliminated. Components used are suitable for mass manufacture thereby ensuring standardisation and interchangeability. The pump head and the hand lever mechanism have been so designed that minimum human effort is required to operate the pump. Maintenance cost has been substantially reduced

Besides WHO and UNICEF, some other international organisations have shown keen interest in the project. The project has immense socio-economic advantage not only for a developing country like India, which has a high incidence of rural population, but also for many other less developed countries of the world where water shortage is acute. 1000 prototypes are under production for extensive field tests.

Use of water hyacinth

Water hyacinth, erstwhile considered as a trouble-weed, may be properly utilized for producing laboratory and domestic fuel (gas) from it. From available data it is known that 2,00,000 acres of land in Bihar, 30,000 acres of land in West Bengal are covered by water hyacinth.

Cowdung gas plant is already known all over the country. To keep a cowdung gas plant in operation, cowdung 5 cows/ oxen will be required for a family of five people. It is however not possible for each villager to have 5 cows. Being readily available, water hyacinth may be easily utilized for the above purpose. Moreover, hyacinth gets decomposed quicker than cowdung. During summer, water hyacinth takes 3 days to decompose while cowdung takes 8 days. During winter the same period is 4 and 12 days respectively. The ratio between the total volume of gas evolved from decomposed water hyacinth and cowdung under identical time and temperature conditions is 5 :3 (summer) and 5:1 (winter) respectively. Unlike cowdung compost, the water hyacinth

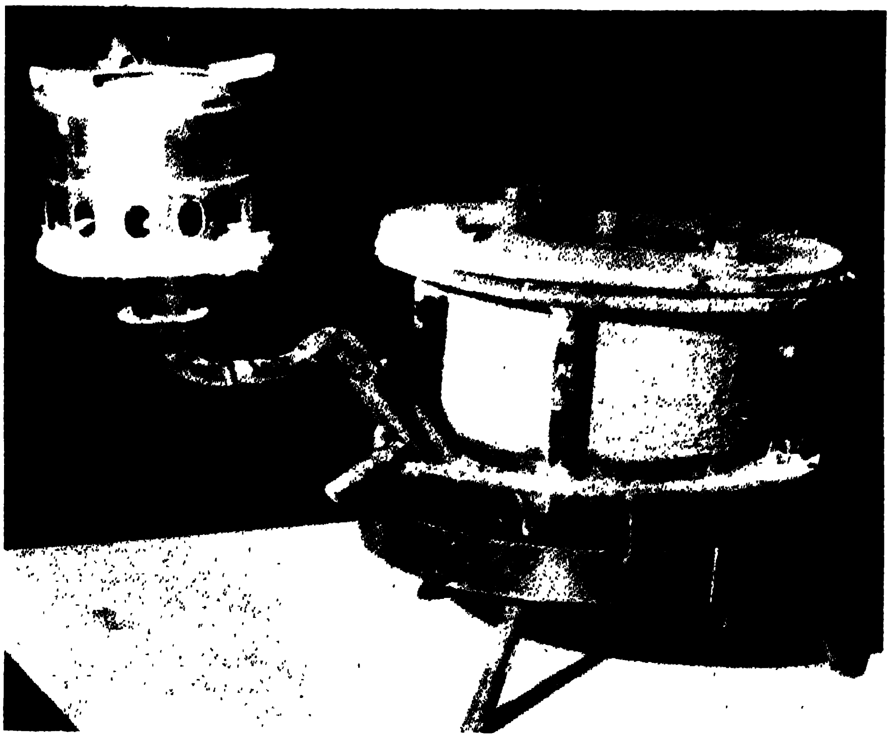


Fig. 3 Domestic oven. It is smokeless and obtains additional burner flame for simultaneous cooking

compost has a rotten smell which, however, is minimised to a great extent when water hyacinth and cowdung mixture is used for producing the fuel gas.

CMERI is presently designing a prototype where water hyacinth, singly or mixed with cowdung, may be used for the production of fuel gas. The rate of production of gas will be higher if cowdung and water hyacinth are put together. The compost of water hyacinth may be effectively used as a good manure comprising nitrogen, phosphate and potash.

Smokeless domestic oven

CMERI has also developed a domestic oven which utilises coal dust or particles as main fuel instead of domestic coal. The oven produces semi-coke from coal dust and charcoal from wooden chips in the annular chamber around the core chamber. And it provides the useful coal-fire for cooking. The volatile matters liberated from the coal dust are burnt in a gas burner thus simultaneously providing a gas fire besides the main coal fire. The charcoal produced in the annular chamber is used for subsequent ignition of semi-coke in the core chamber which effectively reduces the smoke formation.

Namda making machine

The Institute's MERADO Centre at Ludhiana took up in collaboration with RRL, Jammu, the development of a low-cost machine for making *Namda* (a kind of woollen mattress). A prototype of the machine has been fabricated on the basis of MERADO design and is now under testing.

Namdas are almost exclusively made in the country on cottage scale and the operations followed are mostly manual, requiring arduous labour. Indian namdas have a good export potential. During 1973-74, namdas worth rupees 55 lakhs were exported out of a total production value of Rs. 75 lakhs.

Paper lapping machine

CMERI has designed a high speed machine for insulating copper conductors used in telephone cables and for insulating bare copper wire either with paper or with paper and string. Conductor sizes used in this machine are 0.4 to 1.3 mm. in dia. Each machine consists of a supply stand, paper lapping head, string head, capstan and take up. The production rate of this machine is 20 km length of conductor per 8 working hours of each machine.

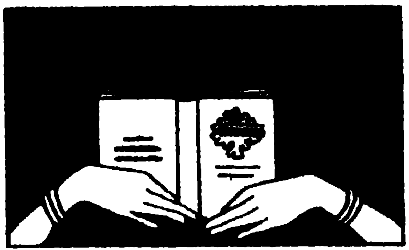
Leather shaving machine

A hydraulically operated wide leather shaving machine has been developed by MERADO, Madras, using only indigenous materials and parts. The project was sponsored by NRDC

Design drawings of the machine have been completed and handed over to the collaborator. The fabrication of the prototypes is nearing completion.

Books Received

1. **ELECTROMAGNETISM, ELECTRON THEORY AND SPECIAL THEORY OF RELATIVITY** by Arun Kumar Dutta, *Macmillan Co. of India Ltd.*, 2/10, Ansari Road, New Delhi-110002, Pp. 332, Rs. 20.
2. **ANTI-CHANCE** by E. Schoffeniels, *Pergamon Press*, Headington Hill Hall, Oxford 0X3 0BW, England, Pp. 123, $ 5.90
3. **RADIATION & LIFE** by Eric J. Hall, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 201, $ 6.95
4. **REFLECTIONS ON BIOCHEMISTRY** Ed. by A. Kornberg, B. L. Horecker, L. Cornudella & J. Ore, Pergamon Press, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 465, $ 9.50.
5. **A MANUAL OF VIRUS DISEASES OF TROPICAL PLANTS** by S. P. Raychaudury, *Macmillan Co. of India*, 2/10, Ansari Road, Daryaganj New Delhi-110002, Pp. 299, Rs. 44.25
6. **A TEXTBOOK OF BOTANY** by Nathawat, Sharma and Sahni, *Ramesh Book Depot*, Jaipur, Pp. 679, Rs. 20.00
7. **AN INTRODUCTION TO THE TAXONOMY OF ANGIOSPERMS** by Tiagi and Kshetrapal, *Ramesh Book Depot*, Jaipur, Pp. 444, Rs. 24.00
8. **PROGRAMMING IN FORTRAN IV** by K. D. Sharma, *Affiliated East-West Press Pvt. Ltd.*, 104, Nirmal Tower, 26 Barakhamba Road, New Delhi-110001, Pp. 240, Rs. 25
9. **THE IMPACT SCIENCE TEACHING** by Narendera Vaidya, *Oxford & IBH* Publishing Co., N-88, Connaught Circus, New Delhi-110001, Pp. 326, Rs. 14.50
10. **HOW CHILDREN DISCOVER KNOWLEDGE** by Narendera Vaidya, *Oxford & IBH Publishing Co.*, N-88, Connaught Circus, New Delhi-110001, Pp. 315, Rs. 11.00
11. **RESHAPING OUR SCHOOL SCIENCE EDUCATION** by Narendera Vaidya & J. S. Rajput, *Oxford& IBH Publishing Co.*(Address same as above), Pp. 258, Rs. 15.00



BOOK REVIEWS

THE WEATHER WEAPON *by* N. Seshagiri, *National Book Trust*, A-5 Green Park, New Delhi-110016, Pp. 190, Rs. 10.00

RECENT advances in computers and space technology have made the job of the meteorologist much easier. Weather satellites today provide instant pictures of the cloud cover, hurricanes and potential storm areas, while networks of ultrafast computers can within minutes process all the available data. This has not only helped scientists in understanding the weather phenomenon better but has also shown possible ways for artificial weather modification. It is this latter possibility, especially the sinister aspect of it, that has prompted the author, a defence analyst, to write the present book. He collected all available information and then carried out computer simulation of 'models' of possible applications as weapons. His conclusion: "as a political weapon it may far exceed in effectiveness the much talked about nuclear blackmail"

But going through the dozen odd chapters, the author's highly biased views and his over-pessimistic outlook become evident. He does not analyse the possibilities and limitations objectively but sees a potential danger lurking behind each of them, often without any valid reason. Many of his statements can at best be called fanciful.

Take for example, artificial rainmaking. The author sees in it a tremendous possibility of creating flash floods in enemy territories. But in reality, the efficacy of artificial seeding of clouds to induce rain is yet to be established beyond doubt. Past attempts have been at best only partially successful.

The author's views on the effect of seeding are also inconsistent. On page 48, for example, he says, ' By implanting seeds of silver iodide in clouds on a massive scale it is possible to release the latent heat of fusion (of ice crystals) so suddenly that the clouds start growing vertically and cause rainfall." While on page 94 we find, "Such a meticulously performed (seeding) experiment showed that with silver iodide seeding rain actually decreased in the seeded area !"

There is a scheme for artificially creating tornadoes, the funnel-shaped swirling storms that can blow a house apart. Any success so far ? In an experiment in the United States, 48 giant burners, after 15 hours of operation, created a funnel-shaped column which lasted only 4 minutes ! How does one steer a tornado into the enemy territory ? The author does not provide the answer, but he is confident that a way can be found.

Can we modify climate by altering the ocean currents ? What about melting the polar ice caps by diverting the warm ocean currents towards them ? What will be the effect of blocking the Bering Strait, or widening the Panama Canal or the Strait of Gibraltar ? Considering the dependence of weather on the oceans there is no doubt any of these actions will effect the weather. But the point is, can such effect be localised to any specific territory, as will be necessary if it is to be used as a weapon ? Obviously the answer is, No. What about the secrecy of such projects. Could they be carried out without the knowledge of the 'enemy' countries ? These are some of the vital questions to which this book does not provide the answers.

Many of the experiments referred to in the book are being primarily developed for peaceful applications. The misuse of some of them cannot be entirely ruled out, but suitable safeguards can be devised. But to magnify the threats out of proportions by taking a one-sided view is, to say the least, to mislead and misinform the public.

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ELECTRONIC INVENTIONS 1745-1976 *by* G W. A. Dummer, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England. Pp. 164, $ 7.50.

WHO's the inventor of TV? The name that comes immediately to our mind is J. L. Baird. Go through this reference book and you will find there is not only one name associated with this 20th Century invention. There are four And, on top of it, Baird is taken as the inventor of only the mechanical scanning system of this device. The electronic theory behind the working of TV, the book mentions, was given by the English man A. A. Campbell-Swinton in 1908, the half-baked electronic system and iconoscope were invented by the American Vladimir Zworykins in 1919 and 1923 respectively. Then came the Baird's invention in 1925. In 1927 Philo Farnsworth, an American, gave the finishing touch to the TV as a complete "Idiot box".

Is not this list of TV inventors a rude shock to the layman, or for that matter, any budding inventor striving to make as miraculous invention as that Baird is claimed to have made? Such rude shocks one gets time and again as one goes through this systematically and chronologically written book.

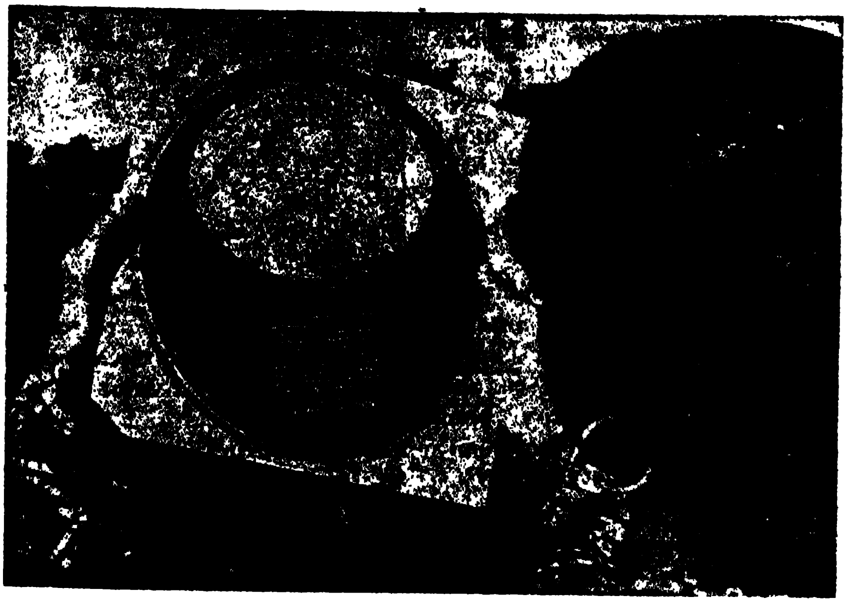
The purpose of the book is to cater to the needs of patent autho-

rities, research organisations, universities, technical colleges and manufacturers. It is a handy encyclopaedia which informs who patented a particular invention and when, and the source-material from which its history of development could be digged out. However, the author has by including with each invention a brief note regarding its historic development till patented, made it all the more a stimulating book. It would take away monotony which otherwise is very much present in such type of books. The book, therefore, would doubtlessly interest both electronically oriented layman and technician.

Besides the list of some 295 electronic inventions mentioned in the book, the author also gives a glimpse into the invention-rate during the period considered, the effect of brain drain from Europe to U. S. A., microelectronics development, etc., by presenting them in a graphical manner. Then there is also a list on inventors, on useful books on inventors, on inventions in date order, etc. Photographs or circuit diagrams of the inventions are given wherever necessity arise.

In the Preface the author has duly acknowledged the fact that some dates and inventors "cannot be accurate" because of the passage of time and conflicting claims. Also, the list of inventors is confined to ones from Europe and the U.S.A. only ; many rival claims which come particularly from Russia and Japan have not been included. The funny thing seen in the book which this reviewer fails to understand is why in the "Sources" mentioned with every invention are there additional headings such as "See also", followed by "Also", and, sometimes, by another "Also". Either the purpose for doing so should have been made explicit or a single heading would have served the purpose.

DILIP M. SALWI



CONSTELLATION AND STAR FINDER by B. V. S. Rao, *Higginbothams Pvt. Ltd.*, Mount Road, Madras-600002. 1977, Pp. 42, Rs. 7.00.

THE sky above has always fascinated man. He has wondered what the millions of the twinkling stars are. He observed the phases of moon and some other luminous bodies. His curiosity to know the unknown was aroused which led him on to the path of knowledge and civilization. Astronomy therefore is rightly called the mother of all sciences.

The sky still fascinates us, but few can identify even the planets belonging to our solar system. Then there are constellation and stars. Every issue of *Science Reporter* carries an astronomical chart for those interested in locating planets of our solar system.

Star gazing is one thing and to locate planets, stars and constellation is quite different. It needs expert guidance and knowledge.

Fortunately, we have the publication by Shri B. V. S. Rao which will help even lay persons in locating the heavenly bodies above our head. The publication is also accompanied with a star finder. It is fixed on hard board and is handy and durable and, above all, easy to use. Shri Rao must be congratulated for having produced this handy device which one can hold in hand and locate heavenly bodies millions of lightyears away from us.

OPTIMIZATION METHODS in Operational Research and System Analysis *by* K. V. MITTAL, *Wiley Eastern Limited*, AB 8, Safdarjang Enclave, New Delhi-110016, Pp. 259, Rs. 15.50.

THE book under review is an elementary mathematical introduction to linear and nonlinear programming, dynamic programming, geometric programming, direct research methods and theory of games, which is based on the lectures given to M.Sc. and M.E. classes and on short term courses under the Refresher Courses Department and the Quality Improvement programme at the University of Roorkee.

The book has been divided into ten chapters. In the first five chapters, mathematical preliminaries, extrema of functions, linear programming, transportation problems, flow and potential in networks have been discussed in detail, while in the last five chapters non-linear convex programming, theory of games, dynamic programming, geometric programming and direct research and gradient methods have been thoroughly discussed. Each chapter is followed by problems to serve as exercises.

Chapter I provides the additional necessary topics of vital importance such as Euclidean space, linear algebric equations, convex sets and quadric forms, which have been explained in a simplified way. Similarly, other chapters have also been discussed in a way which is easier for a student to understand. At the end of every chapter, a short bibliographical note has been given to guide the readers to a few standard books for further consultation. A comprehensive bibliography at the end of the book has also been given to guide the student and research scholar for further study. Most of the chapters can be studied independently of each other.

The book is very well written and will serve as a suitable text book for the students of mathematics, operational research, engineering, economics or management, whose course of study includes the topics discussed in the book. In short, this book is strongly recommend to the students of mathematics, engineering operational research, etc., who already have the knowledge of algebra, calculus and geometry upto the under-graduate standard.

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AN INTRODUCTION TO FLUID DYNAMICS *by* R. K. Rathy, *The Oxford & IBH Publishing Co.*, 66 Janpath, New Delhi-110001, 1976 Pp. 684. Rs. 24.00.

THE book is intended for students of engineering, applied mathematics and mathematical physics, both at graduate and postgraduate levels. It is also useful for those who intend to prepare for examinations in fluid mechanics conducted by the Institution of Engineers (India). Also, the book is an asset for research students and professional engineers, scientists and teachers.

The first six chapters of the book are devoted to basic knowledge of the subject "Fluid dynamics" which includes physical properties of fluids, thermodynamics of fluids, kinamatics of fluids, stresses in fluids, constitutive equations and conservation laws. The next eight chapters deal with the behaviour of fluid flow under various conditions and different fields of applications. These are irrotational and rotational flows, incompressible viscous fluids flows, compressible fluid flows, non-Newtonian fluid flows, dynamical similarity and small Reynolds number flows, boundary layer theory, stability theory and turbulence. The last chapter is an introduction to hydromagnetics which is also called MHD (magneto hydrodynamics). MHD is presently much debated as an alternate source of energy.

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MATHEMATICS FOR CHEMISTS *by* D. M. Hirst, *The Macmillan Press Ltd.*, Representative in India: *Macmillan Co. of India*, 2/10, Ansari Road, New Delhi-110002, 1976, Pp. 303; £ 4.95.

THE book under review presents mathematics required for the study of chemistry at post-graduate level of Indian universities. The approach of the book has been descriptive with emphasis on applications of mathematical techniques in chemistry. The book is unique in its kind; wherever possible the author has illustrated the ideas with examples from chemistry. An elegant discussion on various topics like matrices, differential equations and partial differential equations has been presented. Concepts of eigenvalues and eigenvectors, which are commonly used in quantum mechanics and theory of molecular vibrations, have been discussed in the chapter on matrices. Taylor-Maclaurin series, orthogonal functions and Fourier series have been discussed nicely. These techniques are frequently used in spectroscopy and quantum mechanics. The last chapter of the book on elementary statistics and error analysis gives an introduction to the ideas used in analysing experimental data and in assessing accuracy of the results. In this chapter, author has discussed the various forms of errors which are present in experimental measurements. Statistical methods used to analyse random errors have been discussed in detail.

The format of the book is good. The book represents a significant contribution in the field of mathematics for chemists.

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BINARY SYSTEM (*Continued from page* 359)

There are simple connections between algebra of logic and computers. Boolean algebra invented in 1854 by George Boole of England in which he used two symbols 0 and 1, has tremendous impact on automation of telephone system, railway signalling, switch gear, machines and electronic computer.

For a long period, pure mathematicians devoted time to the fascinating area of number theory. Some of the intersesting numbers are Mersenne number and Fermats numbers. Mersenne numbers are of the form 2^n and Fermats numbers are of the form 2^{2n+1}. These numbers if expressed in binary notation appear simple and can be calculated with the help of computer. One of the largest number containing 967 digits was derived with the help of a computer in the form of 2^{2317-1}. Integers divisible by three also contain an even number of "one" when expressed in binary symbol.

The binary system is also helpful in the problem involving combinational analysis. New relationship in different areas of number theory can be explored with the help of computer and numbers expressed in binary system.

Study of binary number at the school level ensures better understanding of the number system. This has also recreational value. Many numerical tricks are based on binary system.

We find the importance of study of binary system increases as we advance in technology and science.

Further reading

1. Harry M. Davice, Mathematical Machines *Scientific American*, April 1949.
2. W. D. Lewis, *Mathematics Make Sense*, Heinemann Education Book Ltd.
3. Stanislaw, Ular, Computer, *Scientific American* Sept. 1964.

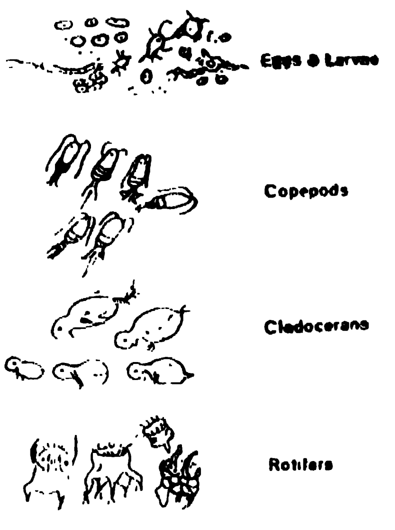

Illustration on page 316 (*S. R.*, May 77 Fig. 2. Zooplankton) is wrong. The Correct is as given above

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S. K. Hajra Choudhury

Head of the Department, Mechanical Engineering, M.B C. Institute of Engineering & Technology, Burdwan

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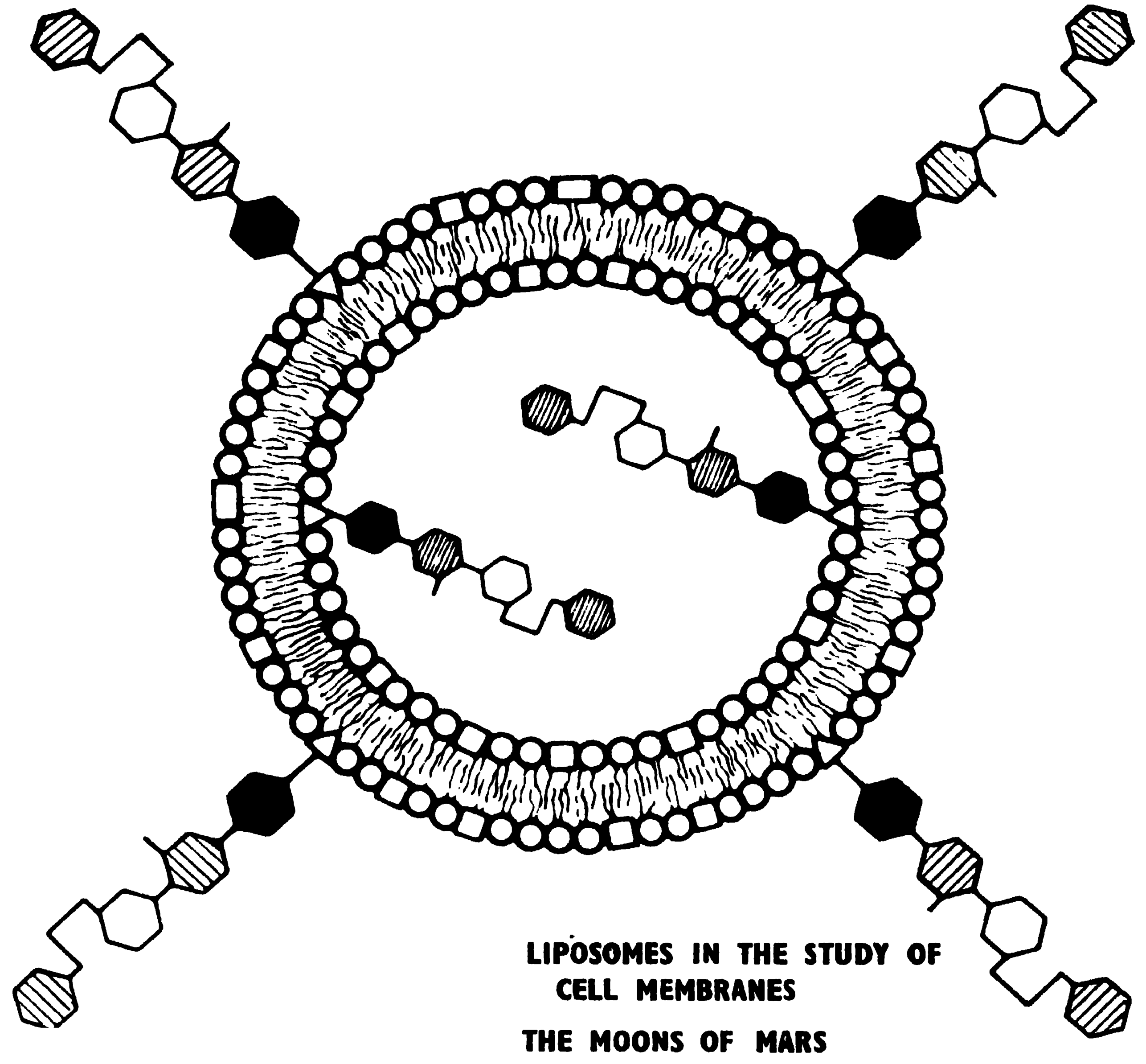

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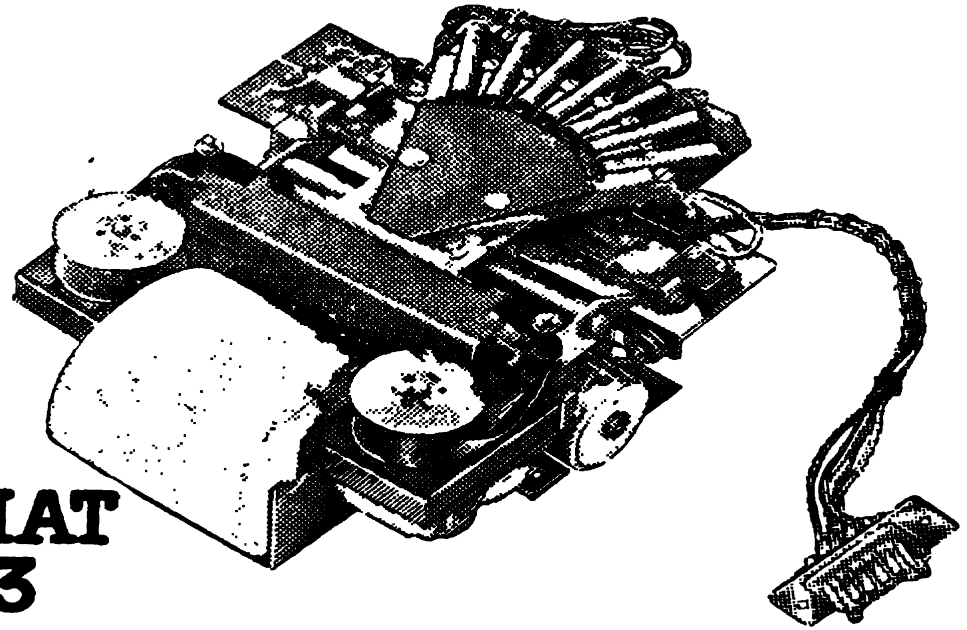

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REPORTER

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LETTERS

Wild life (*S. R.*, March 1977)

Sir, Shri Natarajan says that 200 cheetahs were killed by villagers in celebration of Independence Day. Cheetah is the animal which we have lost for ever. Due to the merciless killing and destruction of its habitat, the species became rare at the beginning of the century. Its sighting and killing have been recorded in the *Journal of the Bombay Natural History Society*, and the last dubious record is one animal seen in the Chitoor District of Andhra Pradesh in 1952 but this was never confirmed nor has there been any report of the existence of a cheetah in India since then. How can the villagers kill 200 cheetahs in 1947 when the species was almost extinct? Perhaps, the author meant "cheetal".

Secondly, we are somewhat fortunate that we have lost only one species (i.e., Cheetah) and not "200 animal and bird species" as the author claims. Even then we should not be proud of our record because at present hundreds of animals and birds are facing extinction. If proper steps are not taken now, Shri Natarajan's wrong statement will become correct.

ASAD RAFI RAHMANI
Deptt. of Zoology
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II

Sir, The article has rightly emphasised the need for the preservation of wild life in India. However, he has made some erroneous statements about pink-headed duck, mountain quail, the distribution of the great Indian one-horned rhinoceros, and the general wild life of Africa compared to India.

The pink-headed duck and mountain quail have been stated to be now rare birds. This is somewhat inaccurate. In fact, the pink-headed duck and mountain quail no longer exist in Indian limits. The pink-headed duck is known to have disappeared from India as early as in 1935 (only one bird in captivity thrived till 1945 in Sir David Ezra's aviary in Calcutta, besides two unconfirmed reports of its shooting from north Bihar in 1948). The mountain quail is believed to be non-existent since 1876.

Contrary to the author's report, the great Indian one-horned rhinoceros is not confined to Assam region. It is also available in the sub-Himalayan region of West Bengal and its distribution extends to Nepal as well.

Africa is richer in wild life than India. It is well-known that Africa is the land of antelope and has a larger number as well as a greater density of its population. India is poor in antelope as compared to Africa. Only two of the species namely the blackbuck and chinkara are found in India. The nilgai and the *chawsingha* (four horned antelope) are also found in India and are generally supposed to be antelopes, but in fact these two belong to a separate group called *Bovinae* having more in common with the oxen than the *Antelopinae*.

It is true that the population of wild life in general has declined due to several reasons. But the remarks of the author that blackbuck and Indian Gazelle (Chinkara) were near extinction do not sound well. In fact, even now the blackbuck and chinkara exist in considerable numbers in their natural habitats.

S. MOHAMMAD ALI
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V-particle

Sir, The V-particle referred to in my article on **Particle physics** (*S.R.*, April 1977) was named *lambda* (λ) in 1953. It was found to be created very quickly which meant that it was a *strong interaction* (SI) but it decayed slowly which meant that it was a *weak interaction* (WI). In order to explain the "curious behaviour" of the "strange" particle lambda, Gell-Mann and Nishijima (1953) realized independently the need of introducing a new quantum-physical quantity, *strangeness*, which is selectively conserved in strong interactions and electromagnetic interactions but not in weak interactions. Despite the selective validity of this law, it successfully predicted the existence of unobserved particles.

VISVAPRIYA MUKHERJI
Indian Instt. of Technology
Deptt. of Humanities & Social Sciences, Kharagpur

Breathing

Sir, Re: **Breathing is related to the posture** (*S.R.*, Dec. 1976). The suggestion that the blocking of the lower nostril to ward off foreign particles is a far fetched idea. Nature is not that protective. The foreign particle could still enter the wind pipe through the other nostril which is just about 2 mm away. The incidental advantage, if any, of the phenomenon might be something else.

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Vitamin C, myth or miracle

Sir, The article on vitamin C (*S.R*, Dec. 1976) was informative. However, it touched only the beneficial aspects of vitamin C. In his article on **Vitamin C, myth or miracle**, Linus Pauling has recommended one gram of vitamin C daily for the normal functioning of metabolic systems in the body. Lewin (1975) observed that ascorbate inhibits the hydrolytic breakdown of CAMP by phosphodiesterase. However, according to the observations of the same scientist, multigram intake of vitamin C, results in increased excretion of CAMP in urine.

SIRAJ HUSSAIN
Deptt. of Microbiology
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Biology teaching

Sir, I would like to say a few words about the interdisciplinary approach in biology. The advocation of interdisciplinary approach in biology by Prof. S. C. Maheswari is laudable.

Already this approach has been adopted in some universities like Jawaharlal Nehru University, Madurai University, Hyderabad Central University, etc. They have done away with botany and zoology and started life sciences and biosciences. Except universities like Jawaharlal Nehru University, it seems no visibly fruitful attempt has been made by other universities in this direction. Unfortunately, they, instead of analysing the biological systems under the light of physical sciences, merely attempt to unify botany and zoology. It may be realised that modern biology is nothing but physics, chemistry and mathematics without which present day biology cannot survive. If we remain slack in implementing this approach, our research in biology will come to a standstill. If we want to break new grounds in biology, this goal cannot be achieved without integrating physical sciences with biology. The obscurantist's view has to change—the old order has to yield place to new.

V. RAMALINGAM
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Crocodiles and black buck

Sir, Apropos of Lala A. K. Singh's article on crocodilians (*S.R.*, Sept. 1976) I would like to point out that otters (page 542) are common in some places such as Amaravathi Dam, Tamil Nadu where muggers are plentiful. True, mugger may occasionally eat young otters but we saw adult crocodiles and otters swimming close to each other with no apparent animosity. Otters may not be as destructive to fisheries as commonly believed for the very same reasons that crocodiles have proved their value as predators/scavengers.

In A. J. T. John Singh's article on black buck he mentions that "a few have been introduced in the Guindy Deer Park." He might be surprised to know that the Black buck population of Guindy Deer Sanctuary (soon to be a National Park and located in the Madras City limits) is over 400 and seems to be the original wild population found in this area.

ROMULUS WHITAKER
Director, Madras Snake Park Trust
and Conservation Centre
Guindy Deer Park
Madras

Random numbers

Sir, Apropos of the article **Random numbers** (*S.R.*, February, 1977), I would like to quote the following from Prof. John Von Neumann's article (*Collected Works V*) 'Any one who considers arithmetical methods of producing random digits is, of course, in a state of sin'. For, as has been pointed out several times, there is no such thing as a random number—there are only methods to produce random numbers and a strict arithmetical procedure of course is not such a method.

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Science oddities

Sir, In "Science oddities" (*S.R.*, Feb. 1977) the star Epsilon Aurigae B is stated to be so large that the entire solar system upto Saturn's orbit can be placed inside it. The same star in George Gamow's book *The Birth and Death of the Sun* has been mentioned as Epsilon Aurigae I. The letter B in the former case probably refers to the fainter companion of the binary system of Epsilon Aurigae and the letter I in the latter case signifies the fact that the radiation of the rarefied, cool, and red giant component of Epsilon Aurigae is mostly in the infrared region.

S. K. GURTU
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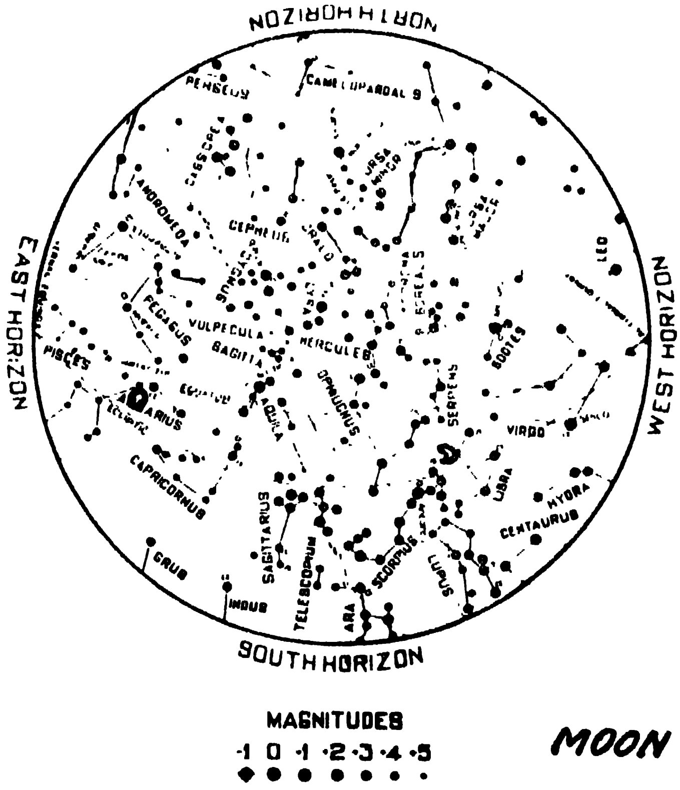
Male hand

Sir, I read *S.R.* regularly with very great interest and it is very useful for science students. **Koel as a brood parasite of crow** (*S.R.*, Jan. 1977) was an interesting article. Cartoons are also hilarious. I found that there are only lady's hands on *News and Notes* and *Book Reviews*. I think that there should

(*Continued on page* 421)

AUGUST 1977



MOON

☽ FIRST QUARTER 22ND

O FULL MOON 29TH

The Moon

New moon occurs on the 15th at 3-01 a.m. and Full moon on 29th at 1-40 a.m. I.S.T. The moon passes four degrees south of Mars on 9th about four and a half degrees south of Jupiter on 10th, about three and a half degrees south of Venus on 11th, and about a degree north of Mercury on 17th. The lunar crescent becomes first visible after the new moon day in the evening of 16th.

The moon is at apogee or farthest from the earth on 9th and at perigee or nearest to it on 24th.

The Planets

Mercury (Budha), an evening star, sets about an hour after sunset during the first three quarters of the month. There after, it is too near the sun to be visible. It is at the greatest eastern elongation of about 27 degrees from the sun on 9th and becomes retrograde on 22nd, It is in leo (Singha). Its visual magnitude varies from+0.3 +1.2.

Venus (Sukra), visible in the morning sky, rises about three hours before sun rise during the month. It passes about seven degrees south of the star Pollus (*Punarvasu*) in the night of 23rd. It moves from Gemini (*Mithuna*) to Cancer (*Karkata*). Its visual magnitude is about-3.5.

Mars (Mangala), a morning star, rises about an hour after local midnight during the first half of the month and about it during the second half. It passes about five degrees north of the star Aldeparan (*Rohini*) on the 1st. It moves from Taurus (*Vrisha*). to Gemini (*Mithuna*). Its visual magnitude is about + 1.1.

Jupiter (Brihaspati), visible in the morning sky, rises about an hour after local midnight during the first half of the month and half an hour after it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about —1.7.

Saturn (Sani) is too near the sun to be visible almost during the whole of the month. It's in conjuction with the sun on 13th. Towards the end of the month, it reappears as a morning star and rises about an hour before sunrise. It is in Cancer (Karkata). Its visual magitude is about + 0.6,

(*Source* : The Nautical Almanac Unit of the Meteorological Office, P-546 Block 'N', New Alipore, Calcutta-53).

COMPUTERS THAT TALK AND LISTEN

VIJENDER SHARMA

Efforts are being made to further simplify computer language. The goal seems to be to make the natural human language also the language of the computers

COMPUTERS have become indispensable to research institutions, industrial organizations and business establishments as calculating devices. It is therefore becoming increasingly important to have a reliable and easy-to-learn communication between computers and their human users. Historically, man's communication with machines or computers can only be in accordance with the operational requirements of the machine. To control computers, it is necessary to learn the special language known as computer language. This language is simply the manipulation of special dials or keys. The errors, which are produced due to any deviation from this computer language, cannot be easily detected because of the complexities of the rules for man-computer communications.

For more than two decades now, the efforts are being made to make the computer language easier. The early computers were coded directly in binary or octal words, then assembly languages were introduced. This led to higher level languages which freed the user from the need to understand many details of a computer. Trials are on to simplify the language further. Today, however, attempts are being made to make the natural human language the computer language. There is no doubt that natural language will continue to be the desired communication medium between computers and their users.

Dr. Sharma teaches physics at A.R.S.D. College, Dhaula Kaun, New Delhi

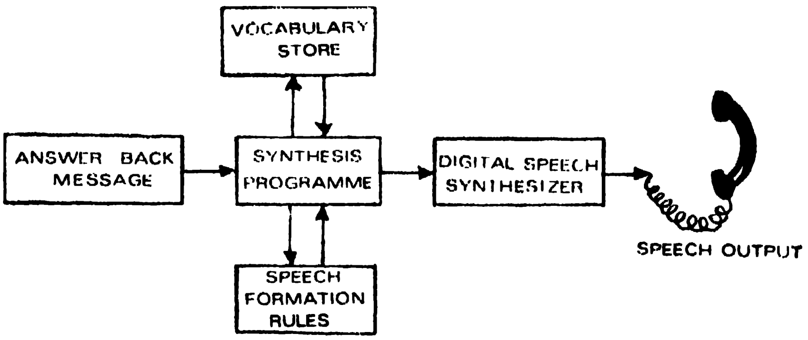
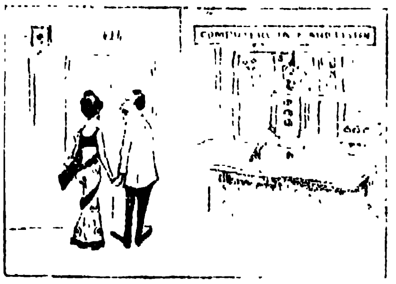


Fig. 1. The voice response system

The natural language can be expressed in two major representations: text and speech. Text is widely used for both computer input and output, but it requires specialized equipment as well as skills (such as typing and reading), which many users do not have. On the other hand, speech can be used directly by the user. It is now possible to make human voice the input of the computer involving no intermediate keying or handwritten steps. As the instructions to the computer are provided in the natural human language, the computer is adaptable to human requirement. Given in these columns, is a discussion of a computer which can talk and listen, that is, the computer for which the language—for problems and their answers—is simply the human voice.

Within the user-computer communication by voice, there exist three general systems. They are voice-response systems, speaker-recognition, and speech-recognition systems. The voice-response system responds to some request for information asked in spoken messages. They are unidirectional communication systems in that they communicate from the computer to the user. On the other hand, the speaker and the speech-recognition systems deal with the systems which communicate by voice from the user to the computer.



'Away from its eyes and ears for an intimate chat with you.'

The task of the speaker-recognition system is either to verify a speaker or to identify the speaker from some known recorded list. On the other hand, the speech recognition depends on many factors such as vocabulary size, speaker population, speaking conditions, etc. The basic task of a speech-recognition system is either to recognize the entire spoken text or to understand it.

Voice response system

The basic features of a computer voice response systems are shown in Fig. 1. The computer is required to speak some message typically specified in ordinary English text. A synthesis programme accesses the required sequence of the words from a stored vocabulary taking into account the speech formation rules. The synthesis programme, then, puts those words together, from head to tail, with the proper duration, intensity, and inflection taking into account the speech formation rules. This description is then given to the digital speech synthesizer device which generates a signal for transmission over a voice circuit. The speech output, thus, can be heard by the user.

This answer-back technique is presently being used experimentally for automated directory assistance, voice-directed electrical wiring, and for travel informations at Bell Telephone Laboratories, in the United States. It has been seen from the field studies that the voice-directed wiring technique reduces the time required to complete the job by about 20% and reduces the errors in wiring by about 50% over the old method of visually locating and reading each instruction from a bundle of computer printout.

Speaker-recognition system

While using the talking and listening computers, it is necessary to recognize and verify the speaker; otherwise, problems can arise about confidential information, for example, personal information provided by insurance clients, inventory status of manufactured products, bank account, etc. Therefore, for security purposes the speaker identification becomes essential.

The task of verification and identification is accomplished by prearranging the verification phrase. When desired the customer speaks this sentence as his identity claim. The computer makes measurements on the entered voice sample and compares the results with the stored reference data it has on file for claimed identity. It, then, decides whether the claim is valid or not.

A schematic diagram of a speaker-verification system is shown in Fig. 2. The system uses a sentence length utterance for verification. It is capable of measuring the temporal patterns of voice pitch, intensity and spectral distribution. Using only the measures of voice, pitch and intensity, it has achieved a verification accuracy of 91%. This level of performance is acceptable for a broad range of business transactions such as reading out customer-bank balances and making credit transactions. A prearranged text must be well remembered to give the added security in such applications. To increase the accuracy and application of voice verification, research is still in progress.

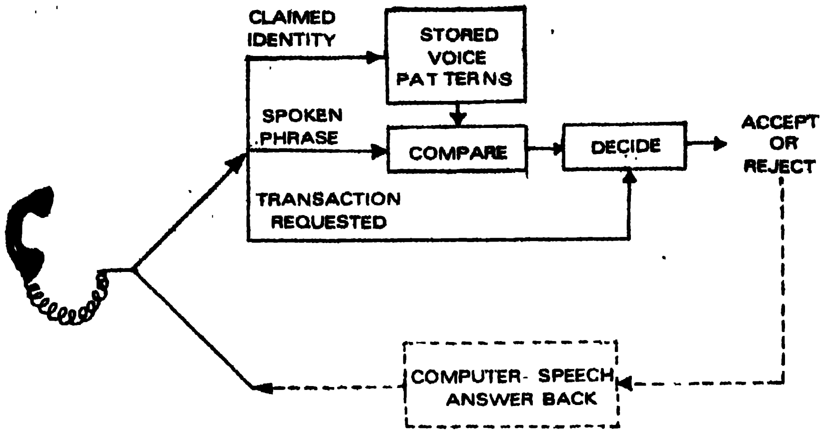
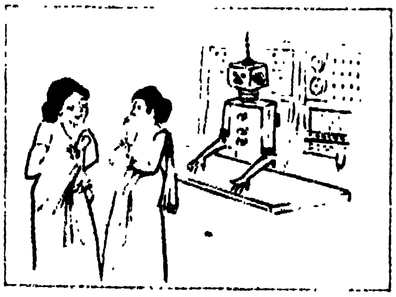


Fig. 2. The speaker verification system

Speech-recognition system

The main aim of this system is to recognise and understand the information supplied to the computer in the form of speech. No doubt there are many inaccuracies in the performance of a speech-recognition system. The system, which can understand the full text provided to it in the form of speech, would indeed be a very sophisticated one. The user here, of course, cannot use all sorts of languages. He has to restrict to some special or well defined language.

There are a few types of speech-recognition systems. The main feature which is used to characterize the complexity of a speech recognition task is whether the speech is connected or is spoken one word at a time. In connected speech, it is difficult to determine where one word ends and another begins. In such cases, the characteristic acoustic patterns of words exhibit much greater variability depending upon the context. Isolated word recognition systems, in which one word is spoken at one time, do not have these problems, since words are separated by pauses.



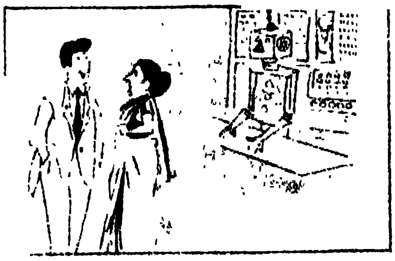
"It says we should learn to talk briefly and listen patiently."

Another feature which affects complexity of the system is the vocabulary size. Higher is the size, higher would be the sonfusability of the computer. The restricted connected speech-recognition systems keep their programme structure simple by having some special knowledge of the work to be done and restricted vocabulary. Moreover, they work on the presumption that the speaker speaks clearly and uses a quiet room. These systems can be used in a wider variety of applications without the need of modification.

At present, systems of restricted use are only available. Nothing can be said about the unrestricted connected speech understanding system, which can have unlimited vocabulary and solve all available problems. For such computers, intensive research is still needed.

Based on such systems, an experimental computer has been installed at the Bell Telephone Laboratories, Murray Hill, in the United States, for giving the flight information. In order to give the information about the flight, the computer first asks many questions from the user. The user gets the answer on dialing the system:

Computer: This is the Bell Labs. flight information system. Please state your flight destination.
Customer: Washington.
Computer: From what airport would you like to fly?
Customer: New York.
Computer: Do you want to specify a date of departure?
Customer: (Supplies the answer).
Computer: At what time do you wish to depart?
Customer: (Gives time).
Computer: How many seats do you want to book?
Customer: (Gives number).
Computer: (Confirms the availability of the seats and thanks).



"No, dear, I do not get bored working with this computer because it listens to me patiently."

Further reading

1. *Proceedings of the IEEE*, April 1976, Special Issue on Man-Machine Communication by Voice.

LIME OR CEMENT?

IRSHAD MASOOD

Lime can be used in place of cement in construction with advantage

CONSTRUCTION of building is dependent on masonry units and mortars in addition to many other operations. The mortar comes second to building units in importance. Chief sources of making mortar are mud, cement and lime. Mud is used but not preferred due to its own limitations. In the present circumstances, particularly in urban buildings, it is always desirable to curtail wall thicknesses to the bare minimum. Cement has dominated all other mortar materials, in spite of its deficiency in several desirable properties. Although other mortar materials are not inferior in quality, the selection has, however, to be made keeping in view the requirements of a particular situation. Lime is one of the main materials for making mortar, but its use now is limited, as every material has its own limitations or advantages.

Lime

Lime is broadly classified as hydraulic and non-hydraulic. Hydraulic lime consists of materials which set under water, and as such is sub-classed as eminently hydraulic and semi-hydraulic depending on the presence of silica, alumina, etc. and the strength produced after 14 and 28 days respectively. Non-hydraulic or fat lime contains very little of silica, alumina and iron oxide but the total oxides of calcium and magnesium (CaO+MgO) are required to be higher than 85%. High calcium lime should contain less than 5% MgO, while the magnesium lime more than 5% MgO. Both these limes are suitable as building lime.

The lime prior to its incorporation in building materials has to be hydrated. The conventional methods of hydration are cumbersome and time consuming. Recently, a process has been developed to hydrate the lime in dry and ready-to-use form by employing a machine costing about Rs. 40,000/- for one ton per hour capacity. The fat limes as well as semihydraulic limes can be easily hydrated by these machines. Hydrated limes possess all the useful properties of conventional lime putty in addition to ease of handling.

Cement

Cement is the term used exclusively for Portland cement which basically has a hydraulic character. It must have the property of setting under water. Portland cement consists mainly of calcium aluminates (C_3A), silicates (C_3S and C_2S) and alumino-ferrite (C_4AF). It also contains a little of free CaO.

Setting and hardening

Cement and cement mortars. The setting of cement takes place due to its reaction with water. The constituents present in cement have a tendency to combine with water and form a gel. When gel formation is completed and the plastic mass becomes elastic, the setting is said to have taken place. This, in the beginning, is due to the early reaction of

---

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Fig. 1. A building constructed in lime mortar

C$_3$A with water. The hardening is obtained due to reaction of C$_2$S and C$_3$S phases with water and formation of hydrates of di-& tri-calcium silicates. The final strength is understood to be produced due to the formation of tobermorite (calcium silicate hydrate) gel which is a platy or fibrous structure similar to that of some types of clay.

Lime and lime mortars. The setting in the case of lime and lime mortars is very slow partly due to mechanical effect of adhesion of fine particles and partly due to the thixotropic effect (of gels, liquifying or being shaken and reforming on standing) in the case of non-hydraulic limes. The hardening is affected due to carbonation of such limes but in the case of lime pozzolana or hydraulic lime mortars, the setting and hardening take place due to similar constituents like those of Portland cement. The initial reaction products, however, may be different particularly in the case of lime pozzolana mixtures. Amongst these two materials, the hydraulic lime mortars may again have a better setting property. The setting may however be improved further by incorporating some set accelerating chemicals in very small amounts. The hydrated forms of calcium silicate and tricalcium aluminate are formed in lime-pozzolana mortars as well. In the case of hydraulic limes, the calcium aluminate hydrate and mono- or di-calcium silicate hydrates are formed which produce early hardening and overall long term strength in addition to that produced by hydration of C$_2$S if present. The semi-hydraulic lime mortars have both the effects combined, i.e., properties of hydraulic and non-hydraulic limes. This type of lime can be used in combination with sand and pozzolana.

Characteristics of mortars

A good mortar should have certain definite properties as listed below :

Workability. It should have good workability which, in turn, depends on plasticity, water retention, etc., so that it can be applied easily to fill up the joints in the structure properly.

Bond. It should ensure good bonding with the structural unit to give tight joints which do not permit water to penetrate into the structure below. It provides overall water tightness.

Strength. The mortar should have sufficient strength to allow the structure to bear the necessary load and resist mechanical damage. But higher early strength increases the chances of crack due to small differential movements in the various parts of the structure. Strength development, therefore, at later stages when the building has settled down would be an advantage.

Rate of hardening. The mortar should also stiffen quickly enough so as not to hinder the speed of construction.

Shrinkage on wetting and drying. The mortar should have low shrinkage on wetting and drying so that the bond with the units is not affected.

Composition. The mortar composition should be such that it does not contain constituents which may cause efflorescence or other volume changes in the mortar later.

Autogenous healing. The mortar should have the character of self-healing, if possible.

The hydraulic lime-sand or lime-pozzolana mortars work better than cement-sand mortars. It is, however, not suggested that cement mortars should not be recommended. Some good properties of lime mortars can be developed by incorporating lime in cement mortars

"I have put more lime than cement to bring your home in the limelight."

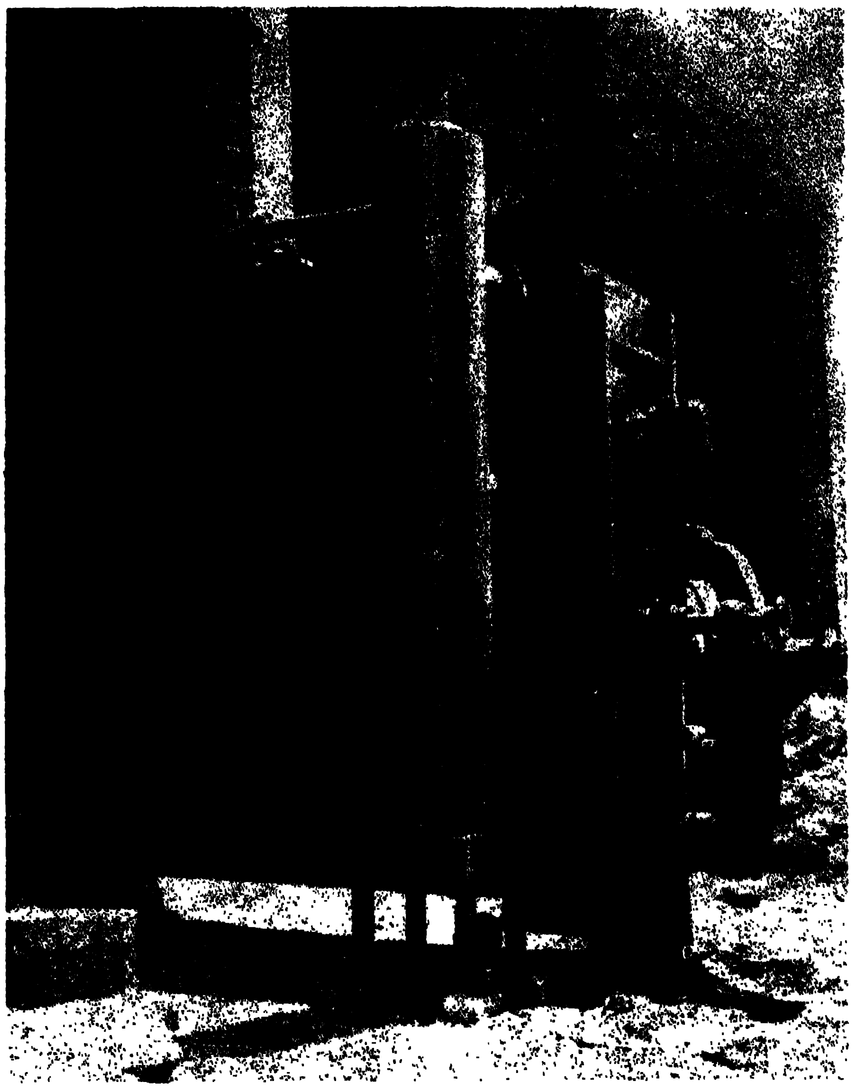

Fig. 2. A machine for hydrating lime

Such mortars are known as composite mortars.

Table 1 makes clear the point that lime mortars possess overall better properties.

The strength properties of lime mortars show that these mortars, like cement mortars, can be used in situations such as single and double storeyed buildings with certain advantages. Lime-pozzolana mortar is also useful for construction of terraces due to its excellent capacity for providing water-tightness as compared to cement. The lime-pozzolana mortars are preferred in foundations and also for cushioning of floors due to their high resistance against the effect of soluble salts, which cause deteriorations of the masonry, particularly in cement.

Advantages and disadvantages

The cement mortar offers some definite advantages by way of controlled setting and hardening properties which affect the speed of construction. The workability, plasticity and water retentivity of cement mortars are generally low. The lime mortars have high workability due to their high plasticity and water retentivity properties. These mortars have better bonding effect and provide better tight joints in the masonry. The addition of lime to cement mortar produces similar effects on their properties, and, in fact, produces a combination of strength and setting with better workability and water retention. The cracking is lower in case of lime mortars due to low shrinkage-expansion under repetitive wetting and drying conditions. As such, lime mortar has a considerable capacity to accommodate the internal stresses. The cement mortars gain strength under water and so also lime mortars along with pozzolanas.

The strength of the mortar is not the only criterion for good masonry. The low strength mortar could give better strength masonry if it possessed other properties like bonding, etc. Lime mortars and particularly the lime pozzolana mortars possess other useful properties in addition to strength.

Lime mortars are suitable for rapid construction if some additives are employed for increasing its early setting. However, hydraulic lime-sand, lime-pozzolana-sand, or lime-pozzolana mortars need proper intermixing and good preparations and grinding at the work sites before actual use. Cement mortars need no such preparations.

This deficiency of lime mortars can easily be overcome by using the machine hydrated lime and well ground reactive pozzolana and sand which can be mixed easily at site just like cement mortars. The Central Building Research Institute, Roorkee, has developed a process for the production of Activated Lime Pozzolana Mixture and made the latter available in ready-to-use form just like cement. This can be mixed with sand to prepare mortars. Another material is for plasters only and is known as 'Rapid Setting Lime Plaster'. It can also be used directly. These materials set and harden within reasonable periods and are being produced by some firms in the country. The ALPM (Activated Lime Pozzolana Mixture) has all the useful

Table 1. Characteristics of cement lime mortar

Property	*Cement mortar*	*Lime mortar*
1. Workability	Low	High
2. Plasticity	Feeble	High
3. Water retentivity	Low	High
4. Strength development (rate)	Fast	Slow
5. Early strength	High	Low
6. Ultimate strength	High	High
7. Hardening rate	Rapid	Slow
8. Autogenous healing	No	High
9. Shrinkage on setting	High	Low
10. Bonding capacity	Low	High
11. Bond strength	High	Moderate
12. Resistance to cracking	Low	High
13. Modulus of elasticity	High	Low

properties of lime-pozzolana mortars and compares well with cement-sand mortars. Such materials are now available packed in bags in ready-to-use form.

As a result of research and innovations in the field of lime and lime pozzolana mortars it is now possible to meet various requirements of modern construction techniques. There is no doubt that the lime mortars have their own merits and it is now possible to remove deficiencies as has been done in the case of ALPM. It can therefore be claimed that lime mortars can find application in general construction like cement mortars by adopting the use of ready mixed Activated Lime Pozzolana Mixtures as well as the standard quality hydrated lime in mortars. Builders can therefore use lime mortars with confidence.

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LETTERS *(Continued from page 413)*

be a man's hand also on *Book Reviews*. I request you to publish articles on fossils and fossilization.

Dharm Pal Singh
35, H.A.K. Hostel
Meerut College
Meerut (U.P.)

Dream

Sir, **The mystery of dreams** (*S.R.*, June, 1976) by Prof. M. Hasan was informative and interesting. As an ardent student of psychology, I would like you to publish articles on theories of emotion, and theories and mechanism of thinking with emphasis on recent developments.

Nagendra Nath Misra
Ravenshaw College
Cuttack-753003 (Orissa)

Suggestion

Sir, I find *S.R.* very useful for science students. **Egg plant** (*S.R.*, Jan. 1977) and **Plants for population control** (*S.R.*, Jan. 1977) were interesting and informative. I would like to request you to publish an article on 'History of medicinal and aromatic plants in India.'

Murari Mohan Roy
Jr. Res. Fellow
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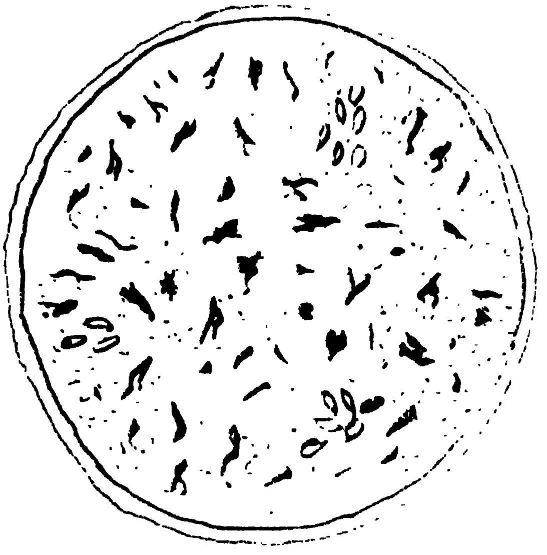


LIPOSOMES as models for the study of cell MEMBRANES

Recent studies have revealed that many biomembrane phenomena can be simulated using model membranes such as liposomes

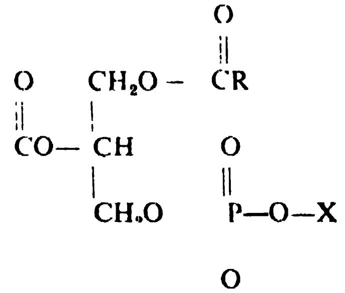
AVADHESHA SUROLIA

B.K. BACHHAWAT

IT has been recognized that the cell membrane is not merely a static barrier between the intra and extracellular environment, but a repository for explicitly localizable molecular machines that pump ions, mediate specific permeability and bioelectric effects, determine and amplify the cell's response to hormones, etc. Modern concepts concerning biological membranes are enunciated in the fluid mozaic model of American scientists S.J. Singer and G. L. Nicolson (1972). The cell membrane matrix, according to them, is a bilayer of lipid molecules into which various protein molecules are embedded in varying degrees (Fig. 1A). During the past decade, studies have been performed with highly simplified artificial membranes made up of lipid and lipid protein complexes. This article shows that some properties of biological membranes cannot only be interpreted in terms of the chemistry and physics of lipids but that many biomembrane phenomena can be simulated using model membranes such as liposomes.

Physicochemical properties of lipids and lipid bilayers

The main constituents of membranes are phospholipids of the general structure.



$$\begin{array}{llll} & & & O \\ & & & \| \\ O & CH_2O - & & CR \\ \| & | & & \\ CO- & CH & & O \\ & | & & \| \\ & CH_2O & & P-O-X \\ & & & \\ & & & O \end{array}$$

where X is a nitrogeneous base, usually choline $[X=CH_2.CH_2.CH_2.N(CH_3)^+{}_3]$, ethanolamine $(X=CH_2CH_2NH_3)^+$ or serine $(X=CH_2CH(COO^-)\ NH_3^+)$. The length of acyl group varies between 16-20 carbon having upto four carbon-carbon double bonds. The

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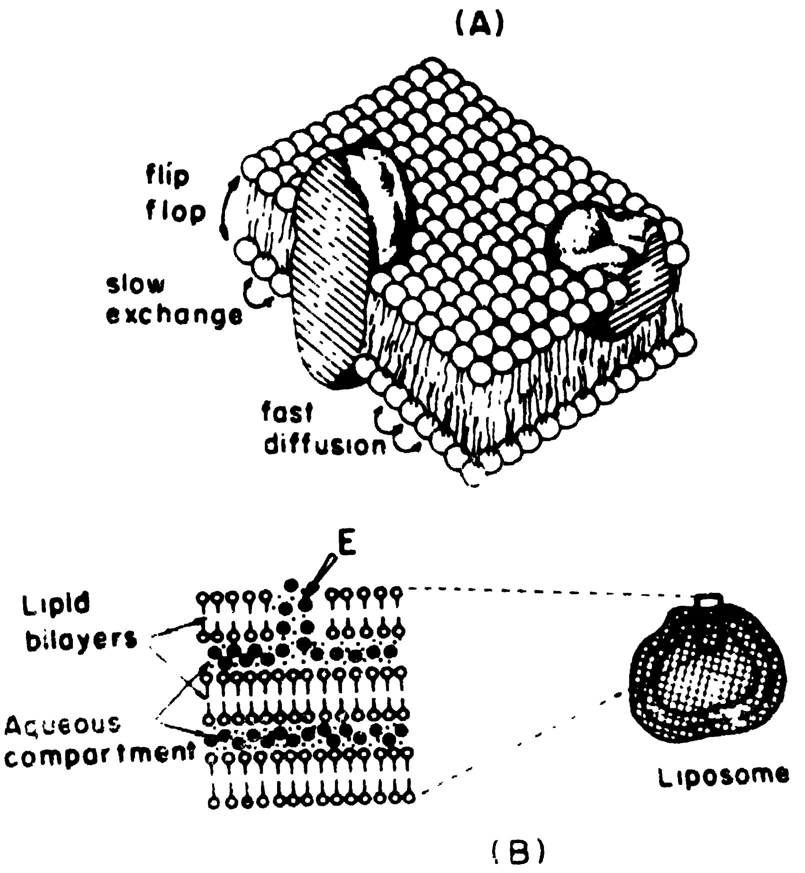

Fig. 1. The Singer-Nicolson model for the cell membrane showing possible modes of lipid mobility (A) and is compared with a bilayer of liposomes in (B)

pioneering studies of A. D. Bangham (1972), a renowned British lipid chemist, showed that when phospholipids films are shaken gently they swell to form onion-like structures, i.e., concentric lipid bilayers alternating with aqueous compartments (Fig. 1B). These multicompartment structures were termed liposomes. The liposomes can be broken down to smaller lipid spherules consisting of an aqueous compartment enclosed by a single lipid bilayer. The thermodynamic properties of phospholipid dispersion favours their organization into bilayered vesicles. On dispersion in aqueous solutions the hydrophobic chains of phospholipids aggregate together with exclusion of water, while their polar head groups lie in contact with water. A number of dynamic motional properties have been established for lipids organized in this bimolecular layer arrangement of lipids. These include a rapid internal motion within each molecule, lateral diffusion of lipid molecules in the plane of membranes, rotation of lipid molecules about their long axes and transfer of lipid molecule from one side of the bilayer to the other—a motion referred to as 'flip-flop'.

The dynamic properties of lipids are influenced to a large extent by temperature. On heating, phospholipids undergo a change of state much below their true melting point. This temperature is known as transition temperature(Tc). At this temperature a change from a rigid crystalline (or gel) to the liquid crystalline state takes place which is characterized by increased flexibility of their hydrocarbon chains. It increases with an increase in the chain length of fatty acid chain and decreases with increasing unsaturation in the chain. The role of temperature on membrane fluidity has been investigated using probes such as aniline napthalene sulphonate (ANS) and bromothymol blue. ANS is an amphipathic flurorescent probe whose quantum yield (measured fluorimetrically) is markedly increased when its hydrophobic ring binds to the apolar region of the lipid bilayer (Fig. 2). In a similar fashion, there is a marked decrease in the molar extinction coefficient of bromothymol blue (BTB) when the latter's aromatic ring structure binds on to the hydrophobic portion of the bilayer. E. Sackman and H. Trauble (1972), the German physical chemists., have titrated ANS and BTB with liposomes at varying temperatures and have shown a three fold increase in probe binding at the transition from gel to liquid crystalline state, thus demonstrating the loosening of polar head groups with a lateral expansion of the bilayer secondary to the increased conformational freedom in the hydrophobic region at the Tc of the lipid, as shown in Fig. 2(b).

Permeability to ions

The lipid state in the membrane can be expected to have a pronounced effect on the function of the membrane. Indeed, when radioactive ions were entrapped in the aqueous compartment of liposomes and their leakage studied as a function of temperature, it was observed that they cross the bilayer with ease only when the lipids are in liquid, crystalline state. The temperature has a strikingly similar effect on natural membranes. Using liposomes Bangham (1972) and his associates were the first to demonstrate the qualitative similarity between the permeability of ions in liposomes and in natural membranes; anions are transported very rapidly whereas the

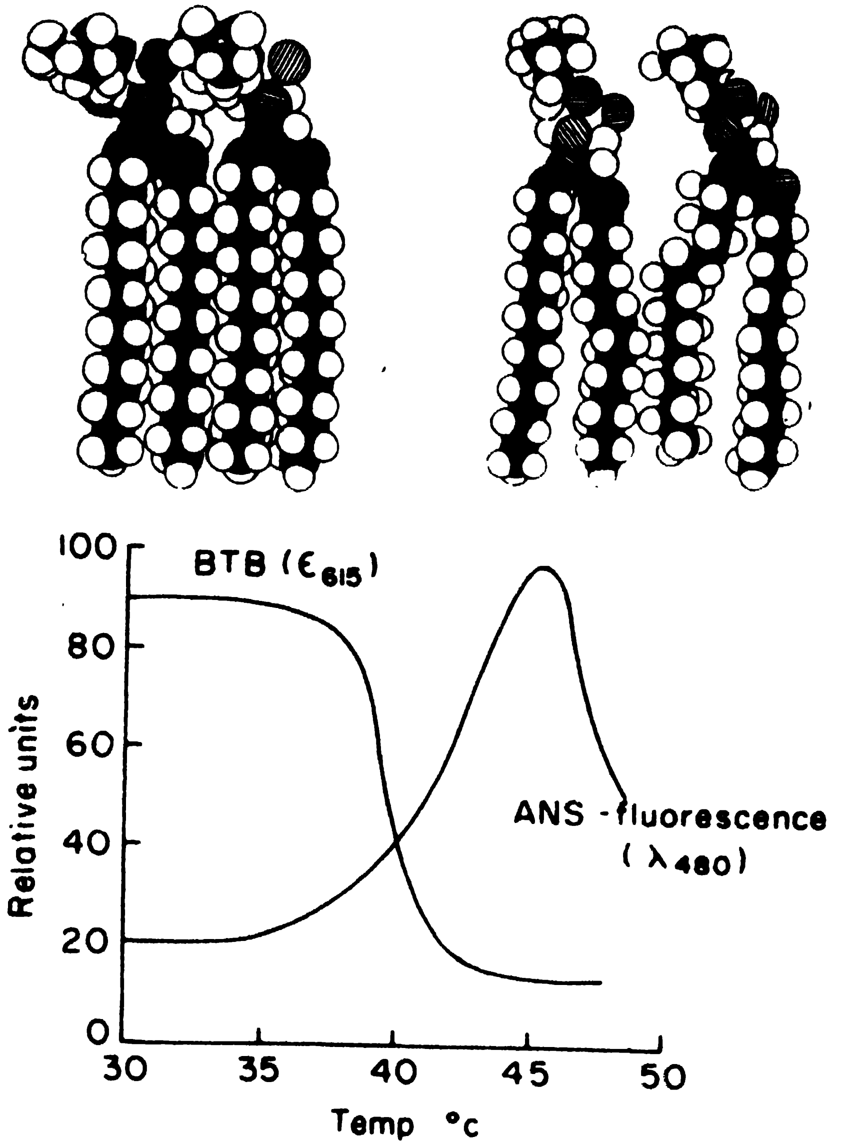

Fig. 2. **Effect of temperature on binding of amino naphthalene sulphonate and bromothymol blue to phospholipid, as measured by increase in fluorescence intensity and absorption respectively. On top, the possible conformations of phospholipid bilayers (a) in the gel phase and (b) in the liquid crystalline phase are shown**

transport of cations is a relatively slow process. The transport of cations was markedly affected by an alteration in the surface charge density (Zeta potential) of the bilayer, a phenomena readily understandable in terms of Gibbs-Donnan ion formulations on natural membranes. The permeability of small molecules (Fig. 3) is correlated with their solubility in a nonpolar solvent relative to their solubility in water. This relationship has led to the suggestion that a small molecule might traverse a lipid bilayer membrane in the following way: first it sheds its solvation shell of water; then it becomes dissolved in the hydrocarbon core of the membrane and finally it diffuses through this core to the other side of the membrane where it becomes resolvated by water . It is pertinent to mention here that the rate of transport of cations through liposomes is slow as compared to natural membranes. In biological membranes, certain proteins are believed to be responsible for conducting ions across membranes of excitable cells to create action potential, while another class of peptide antibiotics perturbs ion gradients and uncouples oxidative phosphorylation in mitochondria. These peptides are known as ionophores. Studies on ionophores incorporated in liposomes have provided models for chemical and physical interactions of relevance to biological transport and membrane excitability. In general two categories of ionophores are recognized; those forming permanent channels across the bilayer and those which act as carriers to shuttle ions from one surface of the membrane to other. G. L. Hazelbauer and J. P. Changeux (1974), French molecular biologists, incorporated partially purified cholenergic receptors from the electric organ of *Torpedo marmorata* into liposomal membranes. These receptors have sodium channels and are activated by acetylcholine, a neurotransmitter, and its analogues such as carbamycholine. On addition of carbamylcholine to these liposomes a selective release of Na^+ was observed. The specificity of action of carbamylcholine was demonstrated by the fact that its antagonist, a toxin from *Naja nigricellis*, completely

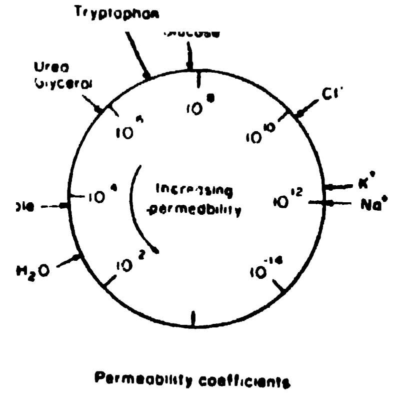

Fig. 3. **Permeability coefficients of small molecules through liposomal bilayer**

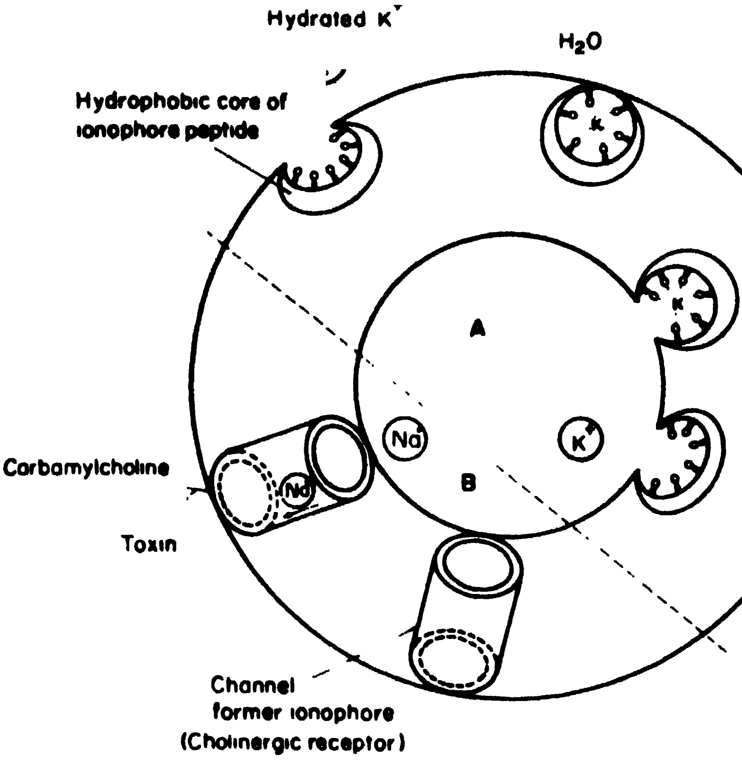
Hydrated K$^+$
H$_2$O
Hydrophobic core of ionophore peptide
A
B
Na
K$^+$
K
Carbamylcholine
Toxin
Channel former ionophore (Cholinergic receptor)

Fig. 4. Diagrammatic representation of carrier ionophore indicating role of change in solvation of ion and conformation of peptide carrier during transport of a cation. Note the chelation of K+by oxygen atoms of the ionophore (A). The transport of ions by channel forming ionophore isolated from brain is shown to be regauted by carbamycholine and α toxin (—— -), the analogue and antagonist of neurotransmitter acetylcholine

blocked the Na$^+$ release. This is an elegant experiment for the *in vivo* role of channel forming ionophores and neurotransmitters and is depicted schematically in Fig. 4 (B).

The studies of German physicists M. Eigen and L. D. Maeyer (1971) have elucidated the mechanism of action of carrier ionophores and is shown in Fig. 4(A). According to them, the cation is stripped of its solvated water molecules seriatin, one by one, as the ion enters the peptic carrier cage and bonds coordinately with oxygen atoms of the cage. Closure of the cage occurs by conformational change. Transport of the peptide enclosed ion through the lipid phase of the membrane is facilitated by the fact that the externally directed side-chains of the peptide are highly hydrophobic. On the inner surface of the membrance the peptide cage opens releasing the ions. Bindings of peptides to various cation varies by several orders of magnitudes, suggesting, a mechanism for the specificity of ion transport observed n biological membranes. Liposomes with suitable lipids in their bilayers have been used to identity the membrane lesions caused by lytic antibiotics. Studies carried out by S. N. Chatterjee and associates (1976) in this Institute have demonstrated that *Vibrio cholerae* and the liposomes made from its phospholipid underwent identical degree of lysis by peptide antibiotic, polymixin B. Phosphotidyl ethenolamine was identified as the site of action of Polymixin B.

Liposomes are currently helping researchers unravel one of the major unsolved problems of bioenergetics: how energy from Wetabolic reaction is harnessed to manufacture adenosine triphosphate (ATP), a universal energy bank in biological systems. Peter Mitchell .1966), a British biologist, suggested that in biological oxidation the elctron transport chain pumps protons (H$^+$) thus creating an imbalance in their distribution bet-

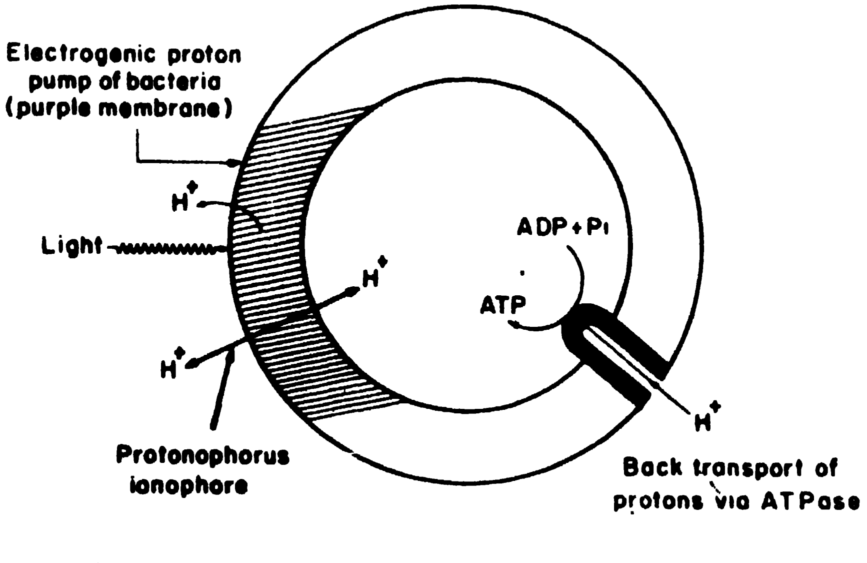
Electrogenic proton pump of bacteria (purple membrane)
H$^+$
Light
H$^+$
H$^+$
ADP+Pi
ATP
H$^+$
Protonophorus ionophore
Back transport of protons via ATPase

Fig. 5. On illumination of Halobacterium membrane transport of protons takes place. The back transport of protons via ATPase produces ATP. The double-headed arrow depicts the disruption of proton gradient by protonophorus ionophore

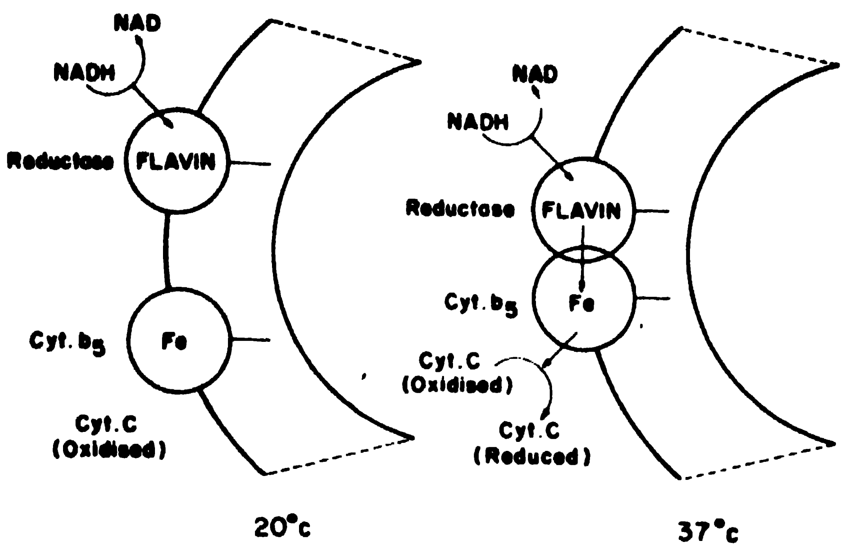

Fig. 6. At low temperature the liposomal membrane is in gel state restricting the mobility of enzymes and the enzymes fail to perform their work. Above the Tc of lipids used for making the liposomes the enzymes are free to move in the membrane performing the reaction

ween the two sides. This leads to a change in electrical potential difference which is restored by pumping back these protons through the inner membrane of the energy transducing membranes, a process mediated by ATP manufacturing enzyme (ATPase). This back passage of protons activates ATPase resulting in the production of ATP. Ingenious experiments of the American membrane biologists W. Stockenius and E. Racker (1974) have proved the validity of Mitchell's hypothesis and are shown in Fig. 5. Liposomes with baceriorhodopsin alone have shown to pump protons on illumination. However when purified ATPase from a different source was also incorporated in these liposomes and light was shone on these liposomes production of ATP occurred. V. P. Skulachev and collegues (1974) in Russia have shown that when this proton gradient is disrupted by protonophorus ionophores, production of ATP does not take place. These experiments are very cogent demonstration of Mitchell's hypothesis.

Phase separation in the membrane

When two dissimilar lipids, differing in their Tc are used to make liposomes below their phase transition, two segregated areas of crystallized lipids are observed. When the temperature is raised the lipid with lower Tc appears smooth whereas the other lipid in the gel phase shows a band pattern in freeze fracture electron microscopy. This confirms the existence of separated regions in the bilayer. The significance of these studies is shown by the observed relationship between the growth temperature of bacteria and fatty acid composition of the membrane lipids. As the growth temperature increases the fatty acid chain length increases and the degree of unsatu-

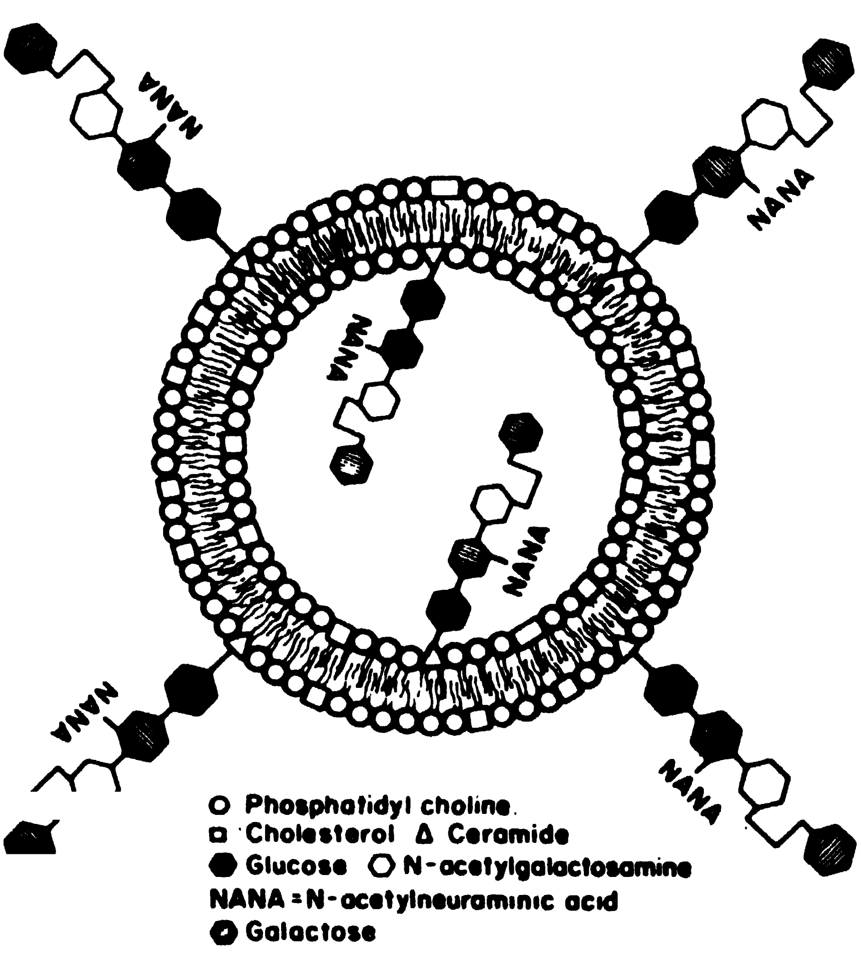

Fig. 7. Diagrammatic representation of a GM1 containing liposome showing the structure and orientation of GM1 molecules on the surface of liposomes

ration decreases. The longer and more saturated the fatty acids, the higher the transition temperature of the lipid. So it appears that the microorganisms are adapted to preserve the proper fluidity of their membrane.

When cholesterol is added to phospholipids while making the liposomes it is observed that they are completely surrounded by fatty acid chains provided the molar ratio of phospholipid to cholesterol is 1.9:1. In liposomes containing less than 33% cholesterol presence of two phases, a pure lecithin phase and a mixed phase of lecithin to cholesterol in the molar ratio of 2:1, is observed. In mixtures of phospholipids the cholesterol will preferentially associate with a lipid which is in a liquid-crystalline state. The effect of cholesterol is to reduce the permeability of lipid bilayers in the liquid crystalline phase and to reduce the motional freedom of the lipid molecules. Recently it has been suggested by J. C. Metcalfe *et al.* (1975) in England, that the active calcium transporting protein is surrounded by phospholipids molecules and functions maximally even in the presence of added cholesterol. However, as the cholesterol replaces phospholipids surrounding the protein, the activity of protein is progressively inhibited. This study directly demonstrates that the lateral segregation of the lipids is essential for some proteins to function.

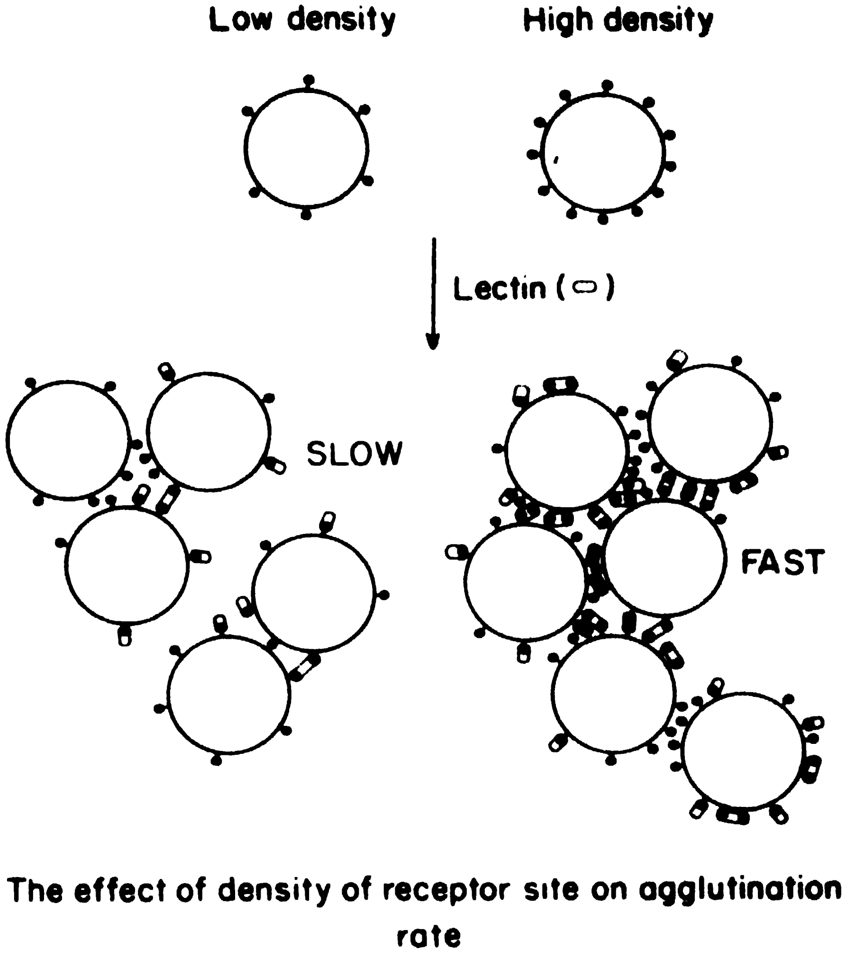
Low density
High density
Lectin (⊂⊃)
SLOW
FAST
The effect of density of receptor site on agglutination rate

Fig. 8. Liposomal model system depicting the lectin-induced increased agglutinability of GM_1 as compared to liposomes with few lectin receptors

Lateral fluidity of the lipid molecules

When phospholipid analogues containing spin probes are incorporated in liposomes, the electron spin resonance lines become broadened in a concentration dependant manner due to spin-spin exchange interaction between paramagnetic molecules. The collision frequency between spin label molecules is calculated from spectral line shapes of various probe concentrations. The diffusion coefficients calculated from the collision frequency show that the lateral diffusion of spin label molecules incorporated into reticular membranes (6×10^{-12} m^2s^{-1}) and the liposomes made from a total lipid extract ($10^{-12}m^2s^{-1}$) are similar. Thus the membrane-lipids diffuse rapidly in liposomes as well as in natural membranes. The lateral diffusion of components in the membranes is strongly dependent on temperature, being very high above the Tc of lipids. Recently P. Strimatter (1975) and his colleagues in America have incorporated cytochrome b_5 and cytochrome b_5-reductase, two iron containing proteins found anchored on the surface of endoplasmic reticulum through a short hydropholic peptide which penetrates into the membrane into pure dimyrisotyl lecithin. The importance of lateral mobility is shown by experiments below and above the Tc of the lipid (24°C). The reaction catalyzed by them, reduction of externally added cytochrome c by NADH, requires presence of the two protein in close proximity. This reaction progresses quite fast at 37 °C, where proteins and lipids are free to diffuse in the plane of the membrane. However, below 24°C when the membrane is in gel state and the proteins mobility is restricted, the reaction is drastically reduced. This experiment (Fig. 6) elegantly demonstrates the necessity of the free mobility of membrane components for their biological activity.

The density of receptor sites and coupling with lateral diffusion

Recently lectins, a group of plant proteins which bind sugar specifically, agglutinate erythrocytes and other cells by crossbridging them by binding to their cell surface carbohydrates. The lectins agglutinate the transformed cells at concentrations which fail to agglutinate the normal cells. This preferential agglutination of cancerous cells has been attributed to as yet undefined changes in their membrane sugars. Studies were undertaken in our laboratory to investigate the mechanism of enhanced agglutinability of transformed cells by lectins. Here again liposome provided suitable model system. Gangliosides are glycolipids in which the oligosaccharides are linked by an o-ether linkage to ceramide—a lipid moiety. Monosialogarylioside GM_1 which contains galactose as the terminal residue was incorporated in liposomes. The interaction of GM_1 liposomes with a galactose binding lectin from castor beans (RCA_1) was studied. Structure of GM_1 incorporated in a liposome is shown in Fig. 7. It was observed that addition of RCA_1 to GM_1 liposome led to their agglutination. This RCA_1 induced agglutination of GM_1 liposomes was markedly influenced by the concentration of GM_1 molecules on the surface of these liposomes; the rate constant of agglutination of GM_1 was increased by 15-20 fold when the concentration of GM was increased merely by 2 fold. Therefore the enhanced agglutinility of transformed cells can be explained by an increase in density of lectin receptor. An increased density of lectin receptors will lead to formation of receptor cluster on initial binding of lectin as shown in Fig. 8. These clustered areas of lectin receptors with bound lectins will increase the likelyhood of many cells comingtogether and hence an enhancement in agglutination.

Liposomes in clinical medicine

Liposomes which till recently were tool for molecular biologists have entered in the realm of clinical medicine. It has been shown that side effects of several drugs and enzymes can be avoided if they are incorporated into liposomes before administration to the animal. The liposomes have thus provided valuable tools for introducing the enzyme or drug directly into the cells *in vivo*. However, attempts have not been made to target the liposome containing enzyme to specific organs. In our laboratory attempts to target the liposome containing invertase to liver were made. This was based on the observations of G. Ashwell and A. G. Morell (1971) and their coworkers in America who showed that glycoproteins containing galactose as the terminal sugar are rapidly taken up by liver. This uptake was due to binding of a protein present on the plasma membrane of liver cells to these glycoproteins through these galactose residues. After binding, these glycoproteins are endocytosed and taken to the lysosomes. This led us to use GM_1 ganglioside liposomes the surface of which carries terminal galactose residue as the labels for entry into liver. Indeed, the uptake of GM_1 liposome by liver was 200%-300% more than the liposomes without galactose. Currently we are investigating other approaches for delivering the drugs directly to other organs. Recently studies of C. Mathias and D. T. Dorai of the Indian Institute of Experimental Medicine have shown that in a model hepatitis it is possible to increase the uptake of curative drug if phosphatidic acid liposomes are used for delivery.

Liposomes in immunology

Complement system takes part in the immune reaction directed against foreign tissues or organisms. It is initiated by the binding of antibody to the surface antigens on an alien cells. First component of complement binds to the antibodies and initiates the reaction where 10 other proteins of complement act in concert to damage the foreign cell allowing its contents to leak. Two possibilities were thought about their mode of action : the last components of complement hydrolyse the membrane lipids or they form a channel in the bilayer through which contents leak out. This was difficult to evaluate on cell systems. The liposomes provided a definitive answer to this problem when S. Kinsky (1973) in the U.S.A. demonstrated that the last five components of complements penetrate through the hydrophobic area of liposomes (or cells) creating a channel through which cell contents leak out. One of the original suggestions about liposomes was that it would prevent production of antibodies to proteins trapped within them. Evidences are accumulating to show that liposomes potentiate the antigenicity of entrapped proteins: they act as immunologic adjuvants. They show a great promise as adjuvants in men, as unlike other adjuvants they are non nonious. They prevent hypersensitivity reaction on repeated injection probably by forming an inert barrier between the antigen and circulating antibody. The antigenicity of virus such as mumps virus which are weak antigens can be enhanced greatly by attaching the virus surface coats to liposomal membrane.

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Significance of Prostaglandins

Of late, prostaglandins have been in news for their therapeutic values. In future, they may prove to be effective against a wide array of ailments

U N. DAS

PROSTAGLANDINS (PGs) were first discovered in the human seminal fluid in 1930 by two New York gynaecologists, R. Kurzrok, and C. C. Lieb, and in 1960 their structure was described by S. Bergstrom, and J. Sjovall, of Karolinska Institute of Sweden. In the beginning, it was thought that prostaglandins were secreted only by the prostate glands. Now it is known that it is present in almost all tissues of the body.

Structure and chemistry

The common feature of PGs is the presence of 20 carbon unsaturated chain of fatty acid. Five basic ring structures of PGs have been delineated depending upon the functional groups present in the cyclopentane ring. They are A, B, C, E and F. The A, B and C types of PGs have unsaturation and keto groups at different positions in the cyclopentane ring, while the E type are beta-hydroxy ketones and F are 1, 3 diols (scheme 1 and 2). Amongst the types, further classification is done based upon the carbon-carbon double bond in the parent molecule. The position of the double bond, either in the cyclopentane ring or side chain, makes all the difference in their biological activity. For example, PGE_1 (prostaglandin E_1) which inhibits aggregation of platelets has no double bond between C_8—C_9 in the side chain, whereas PGE_2 which has double bond at this position has the opposite activity, namely it causes aggregation of platelets (scheme 1). Studies have revealed that prostaglandins have hairpin-like structure.

Synthesis and catabolism

The current concept regarding the synthesis of prostaglandins is given in scheme 3. Only unsaturated essential fatty acids, e.g., arachidonic acid, form precursors of prostaglandins. Esterified prostaglandin precursors cannot be used by the enzyme synthetase for prostaglandin production. The PG synthetase has not so far been purified, and it appears that it is a complex of more than one enzyme. Prostaglandins are not interconvertible and the final product to be formed from fatty acid, whether it is PGE or PGF, is controlled at the endoperoxide level. Prostaglandins are not preformed and stored for any future use, but are formed *exnovo* depending upon the functional state of the cell.

The prostaglandins are degraded by two catabolic enzymes, the PG dehydrogenase (PGDH) and PG reductase (PGR), which are widely distributed in the body.

Mechanism of action

Though the exact mechanism of action of PGs is yet to be defined, it

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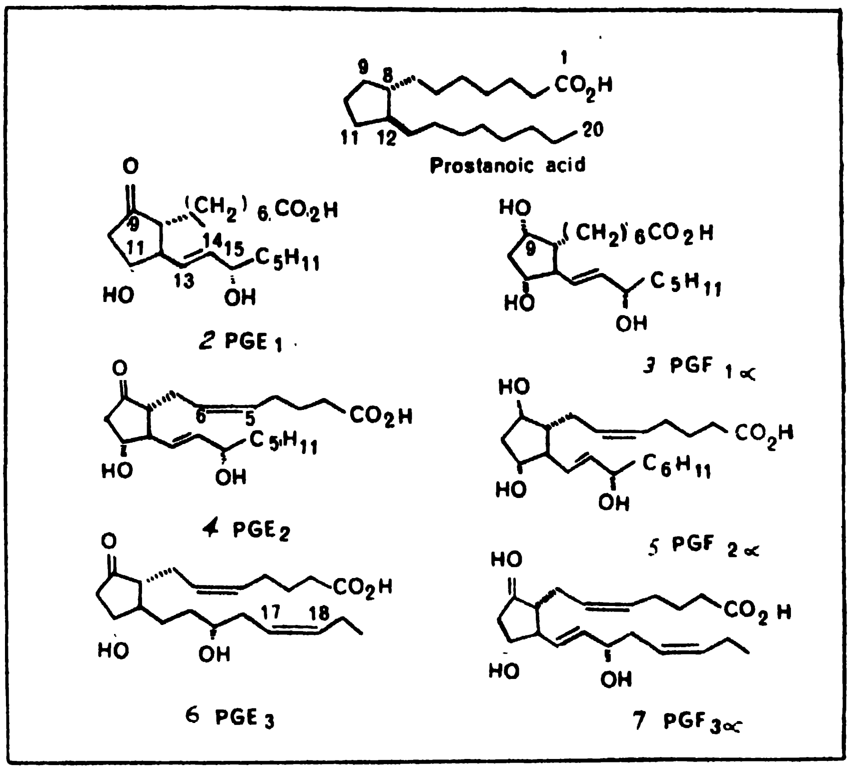


Scheme 1. Prostanoic acid and primary prostaglandins

is clear to a certain extent that they act mainly through 3′—5′ cyclic-AMP (the second messenger). It is said that PGs either stimulate or inhibit cyclic-AMP system and thus bring about their various actions, though the exact interrelationship between cyclic-AMP and PGs is yet to be elucidated. They are also shown to act through other enzymes and chemicals present in various systems of the body. They are described later while dealing with the individual systems.

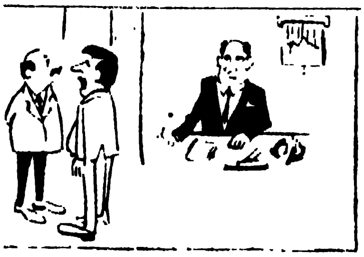
Actions of PGs

PGs have been shown to have a wide variety of actions both *in vivo* and *in vitro*. Different types of PGs have different actions, and some times opposite functions. For example, PGF produces bronchoconstriction (contraction of bronchial smooth muscle) and PGE bronchodilation (relaxation of bronchial muscle).

Reproductive system

Uterus. The action of prostaglandins on uterus was described as early as in 1930's. The stimulating action of PGs on uterus is presently being used in many centres for the induction of midtrimester abortion, and in some centres for the induction of labour.

The type of prostaglandin used for this purpose is PGF_2 alpha whose structure is shown in scheme 1. It is very effective in minute doses. It has a few side effects. In doses of 2.5 micrograms/minute to 40 micrograms/minute it induces abortion within 4 to 5 hours. But the problem with it is that it produces hypertonicity of uterus which is injurious to the foetus because it causes foetal distress. The other but common side effects are vomiting and diarrhoea, which can however be controlled easily. Now PGE is being tried instead of PGF. In fact it was found that PGE is better than PGF for inducing abortions and labour.



"I mentioned to him that prostaglandins may also have aphrodisiac property and, lo, he gave me all the money I needed for research on prostaglandins."

Pituitary. It has been shown that prostaglandins cause release of growth hormone, ACTH, TSH and increase levels of 3-5 cyclic-AMP. They also act on the pituitary gonadotrophin function by increasing the secretion of LH (leutinizing hormone) and LHRF (LH releasing factor). The mechanism by which the PGs act on pituitary is not well understood. But it appears that they act directly on the pituitary tissue because their levels in pituitary increase whenever there is increased secretion of pituitary hormones. Hormones secretion decreases or is absent when PG inhibitors like aspirin and indomethacin are given.

Central nervous system

The exact role of various prostaglandins in the nervous system is also not yet clearly known. It has been shown that the release of PGs by neurons (nerve cells) depends on the activity of neurons. The production is at the peak when neurons are stimulated by analeptics (respiratory stimulants). The amount of prostaglandin production by neurons therefore gives an indication about their activity. Recent studies have shown that not only neurons, but the glial tissue also is capable of producing prostaglandins. PGE and PGF alpha prostaglandins have been isolated from the brain tissue. Other actions of PGs are :

(a) Fever is a common manifestation of many infections. It is thought that pyrogens produced by the microorganisms act on the anterior hypothalamus and cause fever, by increasing heat production and decreasing heat loss. The chemicals mediating this pyretic response were once thought to be serotonin and epinephrine. But now experiments have shown that PGE_1 is a powerful pyrogen and its site of action is anterior hypothalamus, the same site where other pyrogens act. So, it can be suggested that PGE_1 is produced by the hypothalamus following exposure to the pyrogens. It has also been shown that serotonin stimulates production and release of PGEs, suggesting that the old hypothesis on the role of serotonin in the causation of fever is not altogether wrong. The other evidence which supports the role of PGs in the production of fever is the findings that PGE level is increased in the cerebrospinal fluid (CSF) during fever, and that it is decreased after the fever has subsided. But one question still remains to be answered, that is, whether PGs have any role in the normal regulation of body temperature or not.

(b) As it has been shown that PGs can induce sedation and that this effect is dose-dependant, it is believed that PGs can modify behavioural pattern. The site of action is believed to be the brain-stem.

(c) A subcutaneous administration of PGE causes decreased intake of food. The exact mechanism of this effect is not known. PGs may possibly have a role in the regulation of energy balance.

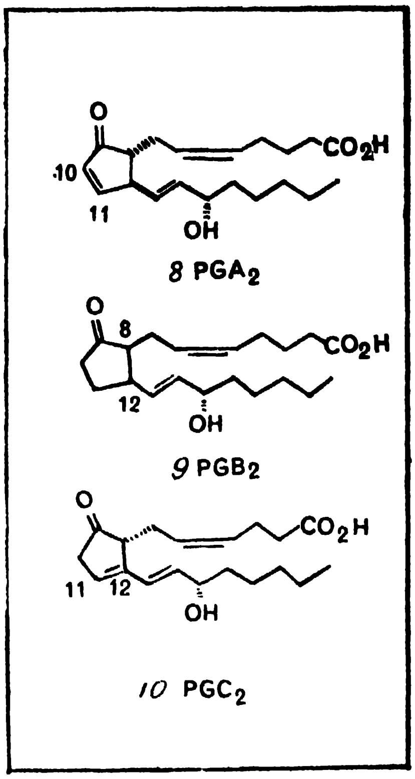
(d) Experiments have shown that PGs can modify the response of neurons to various stimuli, and that PGs can regulate the release of norepinephrine and this has a role in neurotransmission.

Cardiovascular and renal systems

There is now evidence to suggest that PGs have an antihypertensive role (i.e., reduces blood pressure). When PGA is given to hypertensive animals (experimental hypertension), it produces a fall in blood pressure, increases renal blood flow and promotes water and sodium diuresis (increased urine formation).

Though kidney is intimately linked with the pathogenesis of hypertension (experimental, renoprival and renovascular) there is evidence to suspect that kidney also has an antihypertensive function. The renal medullary extracts of both animals and humans have been found to produce a sustained fall in blood pressure in experimental animals. The extract is known to be a fatty acid and is identified as a prostaglandin fraction. Of all types of prostaglandins it is PGA_2 that has the greatest depressor effect on blood pressure. PGF_2 alpha has the opposite effect, namely vasoconstriction and rise in blood pressure. Though PGE is also known to lower blood pressure, there are notable differences between PGA and PGE. They are: (a) PGA has few effects on nonvascular smooth muscle whereas PGE notably causes contraction of the same, (b) PGE when given intravenously is degraded in the lungs whereas PGA escapes this, (c) PGA acts less quickly when compared with PGE, but its action lasts longer and hence is more ideal for use than PGE, and (d) PGA inhibits renal oxidative metabolism and enzyme Na^+—K^+—ATPase, both in the renal cortex and medulla, whereas PGE cannot do this.

Recent developments in radio immunoassay technique has greatly helped in evaluation of the possible role of PGA_2, both as an antihypertensive and a natriuretic hormone (i.e., one which increases urine formation). Though the evidence so far accumulated strongly supports that PGA_2 could be the natriuretic hormone, yet more confirmatory studies are to be carried out.



8 PGA_2

9 PGB_2

10 PGC_2

Scheme 2. Some other natural prostanoids

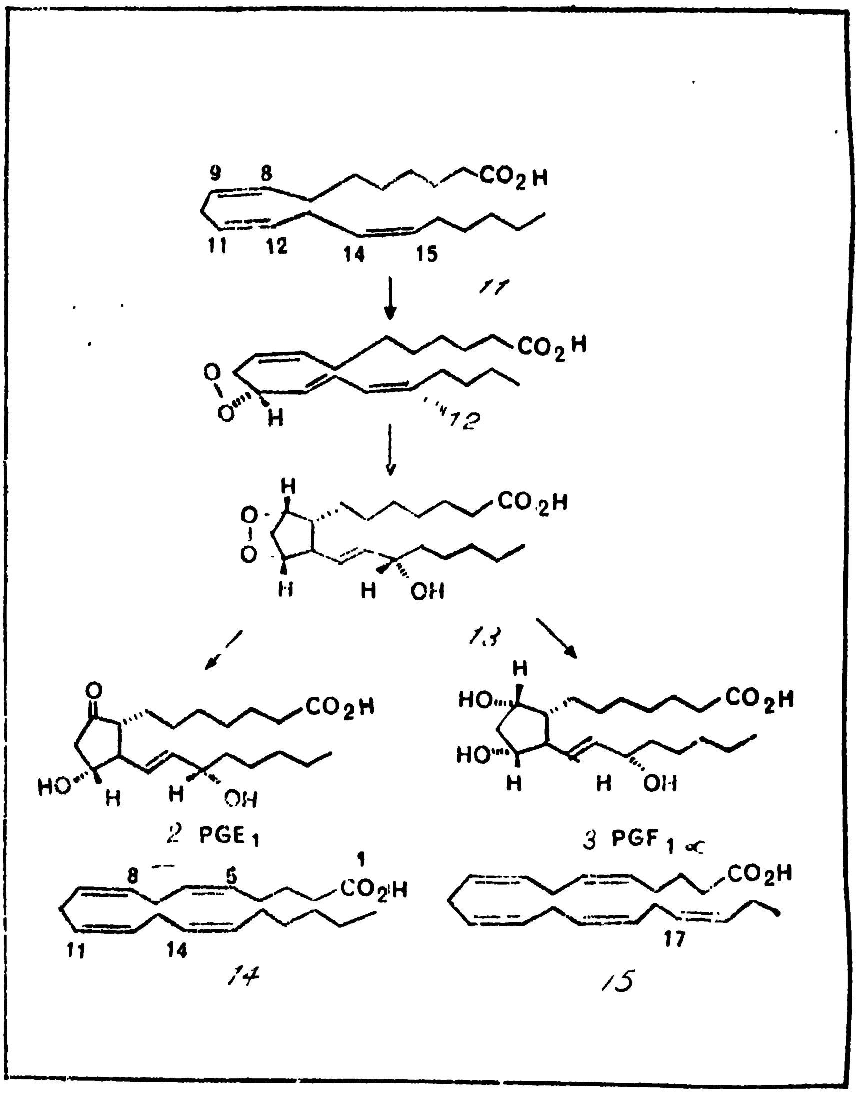
Mechanism of action

The exact mechanism of action of prostaglandins in kidney is not known. As far as its antihypertensive action is concerned, it is chiefly by peripheral vasodilation and decreased vascular resistance.

PGA_2 is known to inhibit renal oxidative metabolism and enzyme Na^+—K^+ ATPase, in both renal medulla and cortex, and probably in this way inhibits sodium reabsorption and increases sodium excretion.

Respiratory system

The role of PGs in respiratory system has been studied mostly in relation to bronchial asthma. Prostaglandin E is a bronchodilator and PGF compounds are bronchoconstrictor. Propranolol, a beta-recep-



Scheme 3. Biosynthesis of prostaglandins: 11. 8, 11,14 Eicosa trienoic acid, 13. Endoperoxide intermediate, 14. Arachidonic acid which gives rise to PGE$_2$ and PGF$_2$ alpha, 15. 5, 8, 11, 14, 17 Eicosa pentaenoic acid which forms precursor for PGE$_3$ and PGF$_3$ alpha

tor blocking drug, does not prevent bronchodilator property of PGE (under normal conditions blocking of beta-receptors causes bronchoconstriction) showing that the bronchodilator property of PGE is independent of these receptors. Furthermore, prior administration of PGE has been shown to suppress the subsequent release of histamine and SRS-A (slow releasing substance-A) which are mediators of allergic reaction. PGEs are not only bronchodilators but are also antiallergic and, hence, promise a possible use as an antiasthmatic agent.

Inflammation

There is now growing evidence that PG may be one of the mediators of the inflammatory response. It has been shown that PGE$_1$, when given intradermally, causes sustained and pronounced erythema (redness), vasodilation and to some extent pain. PGE$_1$ and PGF$_1$ alpha increase collagen synthesis and that is how PGs are supposed to be responsible for the transition of acute inflammation to a chronic one.

Stimulation of tissues by mechanical, hormonal or neurological means has been shown to be associated with an increased PG synthesis. Experiments have indicated that PGs may be the terminal mediators of the acute response. And there appear to be three distinct phases: an initial release of histamine and serotonin, a second phase mediated by kinins, and a third phase the mediator of which is supposed to be prostaglandins. It has been found that the polymorphonuclear leukocytes release PGE$_2$ during phagocytosis, which strongly supports the possible role of PGs in inflammation and injury. Human skin also possesses substrates and enzyme systems essential for the formation and metabolism of prostaglandins.

J. R. Vane (Department of Pharmacology, Institute of Basic Medical Sciences, Royal College of Surgeons, England) in 1971 had shown a dose-related inhibition of prostaglandin formation by indomethacin and aspirin which are known inhibitors of prostaglandin release. These anti-inflammatory drugs inhibit the PG synthetase activity. The steroids are supposed to interfere with prostaglandin system, at one point or other, and produce their anti-inflammatory action. Prostaglandins are definitely linked with the process of inflammation and may very well prove to be the substance involved in the pathophysiology of burn syndrome, chronic inflammation and arthritis.

Gastrointestinal tract

W. Vogt (Department of Pharmacology, Max Planck Institut Fur Experimentalle Medizin, Gottingen, Germany) showed in the year 1949 that a material isolated from frog intestine is capable of stimulating smooth muscle, which was later identified as a mixture of prostaglandins E$_1$ and F$_1$ alpha. Prostaglandins are found throughout the gastrointestinal system and appear to be directly involved in the biological functions of the gut.

In vitro experiments have indicated that PGE compounds in general relax the gut smooth muscle. E. W. Horton (School of Pharmacy, University of London, England) in 1969 noted that after the administration of prostaglandins the subjects complained of mild abdominal distress, and after sometime passed loose, watery stools. An apparent increase in bile reflux into the stomach was also noticed. Some investigators have also reported crampy abdominal pain, diarrhoea, or both, in patients receiving prostaglandins as abortifacients. PGE_1 and PGA_2 consistently relax the lower esophageal sphincter, whereas PGF_2 alpha generally produce an increase in pressure of the same.

Gastric secretion

A. Robert, and others of the Department of Experimental Biology, The Upjohn Company, Kalamazoo, Michigan, U.S.A. reported in 1968 that PGE_1 and PGE_2 had inhibited gastric secretion during the latter's stimulation of secretion by histamine or food in experimental animals. The PGF_2 alpha had no action, however. This was confirmed by other workers too, and it was found that PGE_1 is a potent inhibitor of gastric secretion of both the types—basal and histamine-induced. Similar observations have also been made in man, and it is now presumed that in future prostaglandins may be of help in the treatment of peptic ulcer. It is however still not clear as to how PGs bring about decrease in gastric secretion.

Haematology

PGs seem to be intimately involved in the control of aggregation of platelets. This action appears to be via modulating the levels of cyclic-AMP in the platelets. PGE_1 is the most potent naturally occurrring inhibitor of platelet aggregation. On the other hand PGE_2 aggregates platelets. Because of its action, PGE_1 is now-a-days also used for harvesting and preserving platelets.

Infusion of PGE_1 or PGE_2 stimulates erythropoiesis (RBC formation). This might be by its direct action on erythropoiesis or by increasing the production of erythropoietin. PGE_1 promotes sickling of erythrocytes in the patients of sickle cell disease. This has an exciting therapeutic possibility, because PG inhibitors like aspirin and indomethacin may be used in future to prevent or reverse a sickle cell crisis.

The actions of PGE_1 and PGE_2 on the red blood cells are very interesting. For quite sometime it has been known that red blood cells can change their shape readily. This has been termed "deformability of RBC". This property of RBC is essential because most capillaries are smaller than the major diameter of RBC, which means that the RBC must change shape in order to traverse most capillaries to carry on its primary function of oxygen delivery to the tissues. PGE_1 has been shown to increase the deformability of RBC, whereas PGE_2 decreases this ability. PGF_2 alpha produces, at 10^{-9} M concentration, an increase in deformability of RBC only in women taking birth control pills or during ovulation. It means that sex hormones influence PGs action. These actions of PGs on RBC assume great importance with the demonstration that RBC deformability is decreased in certain cases of burn shock and septic shock. It is also known that tissues lining capillaries and blood vessels have complete prostaglandin system in them, and hence it is possible that these tissues can modulate circulation by releasing prostaglandins whenever necessary. It is also possible that RBCs are acting as messengers of the control system by carrying signals of prostaglandin-borne messages from one tissue to the other for the synthesis of prostaglandins, because of their (RBC) extreme sensitivity to PGs (10^{-10} M) and the fact that RBC cannot synthesize PGs.

Therapeutic potential

The various actions of PGs make them therapeutically important. It is proposed that in future they may be used in lowering blood pressure, curing asthma and peptic unlcer, preventing formation of blood clots and thrombosis, inducing abortion and labour, and for other purposes. Though the present knowledge about the physiological role of prostaglandins in many systems is still meagre, they hold a good promise in medicine and the next decade may very well be the decade of prostaglandins.

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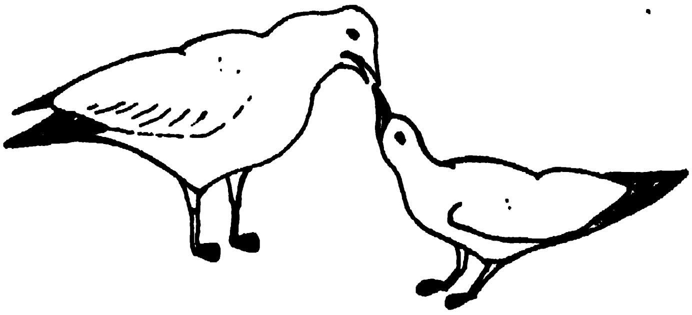
HOW ANIMALS APPEASE EACH OTHER



Appeasement in animals provides not only chances of survival but also better adaptability and mutual understanding

B. L. BRADOO

SOME animals display a variety of behavioural patterns called appeasement displays. By such displays, animals inhibit or suppress aggressive tendencies, arouse sexual desire and convey friendly intentions to other fellow members.

What is a display ?

Display is a natural or hereditary (innate) behaviour performed by an animal in response to some environmental features . The behavioural activities that release a display are called releasers. Displays are characteristic for each species, and they convey some information to other members of the same species (intra-specific display) or between the members of different species (interspecific display).

Sometimes an animal may perform a particular display in the absence of a specific releaser stimulus. Such untimely displays were called 'displacement activities' by Dr. N. Tinbergen (1952) of the University of Oxford. For example, when two birds are fighting, one or both of them may suddenly behave as if they are picking up some imaginary food particles. They may pick up some sand grains only to be thrown away, or they may preen their feathers. Such imaginary food picking or displacement preening in the midst of a the bouts of fighting performed under 'tension' are examples of displacement activities.

Types of behavioural displays

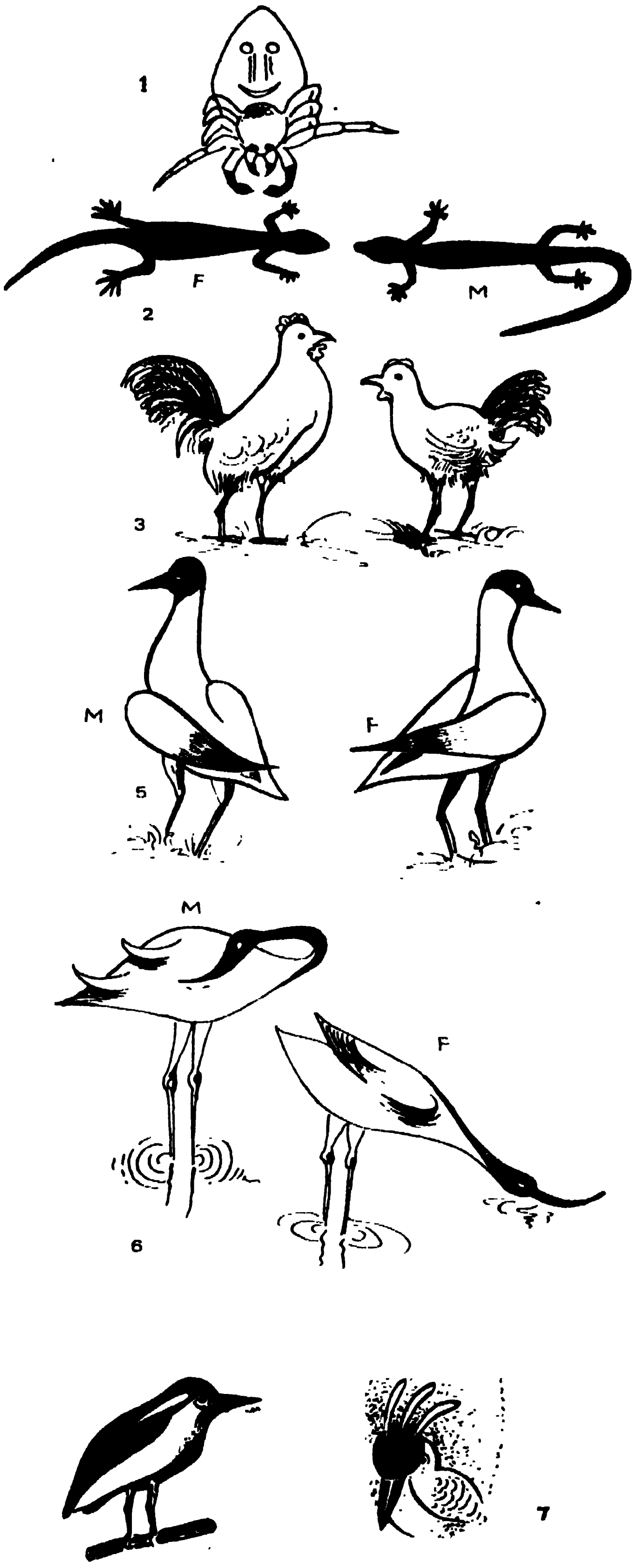
Displays in animals are classified into various types. The well-known are *courtship displays* which convey sexual intentions of a male and a female for copulation. Animals which live in groups generally display a social rank and individual status to their fellow members by some characteristic postures or by sounds, and sometimes by facial expressions. Dr. A. D. Blest (1957) has shown that some animals display prominent warning colours or suddenly expose false warning colours. Such examples are found in several species of moths. When disturbed, the prominent eyed Hawkmoth suddenly displays large eye spots, to distract and frighten the predators. Puffing of the body by some toads in the presence of a predator (a snake) is also a protective display as it makes it difficult for the snake to eat the prey.

Some animals show *social communicatory displays* for conveying some important information to other fellow members of the colony. For

Dr. Bradoo teaches zoology at D.A.V. College, Chandigarh example, the characteristic dance display of the honey bees conveys information to fellow bees about the source, direction and approximate distance of the food from the hive. Similarly, the 'alarm calls' of crows and many other birds are sonic (sound) displays that bring many individuals together to mob and confuse the predator (a cat). The sonic display represents an innate (hereditary) response which may be given by a solitary bird even when no other members of its own species are present. The predator acts as a releaser to the birds who give the warning signal by producing sounds. The social communicatory displays can also work at an interspecific (between members of different species) level. The alarm calls of 'Bulbul' (*Malapestes*) at the sight of a predator (a hawk) makes sparrows rush to some hedge for protection, pigeons (*Columba livia*) come out and fly together in a flock. It is certainly difficult for the hawk to catch an individual out of a flock.

The *care soliciting displays* given by the young of many animals are well known. The young ones of most birds display wide-opened coloured beaks and vigorously beg their parents for food. The colour of the buccal cavity and cries of the young act as releaser stimuli to the parent bird to feed the young. They never feed or defend those chicks that are dead or are incapable of providing the required releaser. The cries of the human infants and young ones of many other mammals are examples of care soliciting displays.

Those behavioural displays that convey intentions of agonostic (aggressive) behaviour are called *threat displays*. Threat consists of special postures or movements of certain parts of the body (visual threat displays) or may be

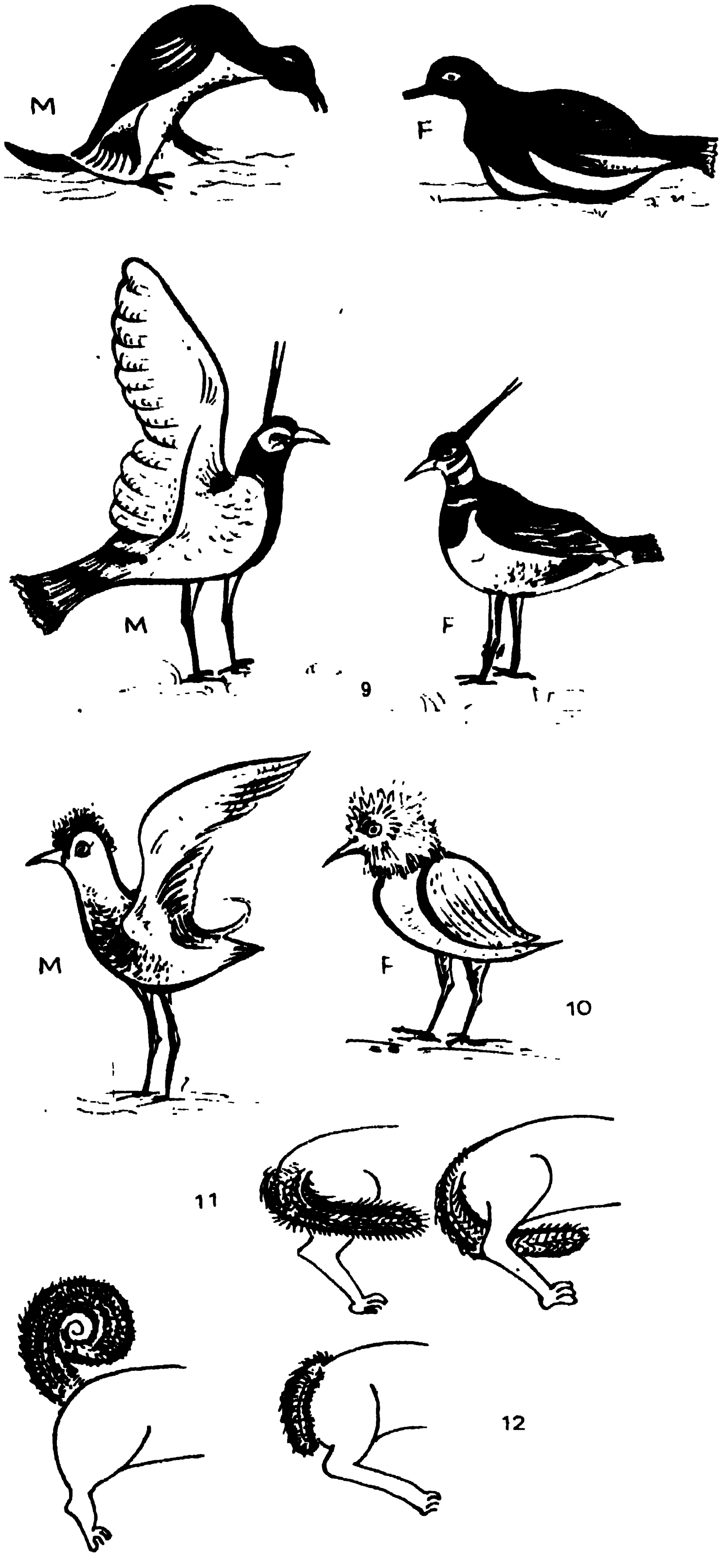


Figs.1. Male *Hasarius adansoni* displaying. 2. Tail wagging in wall lizards. 3. Appeasement display in domestic hen. 4. Food-begging by female herring gull p. 434 5. Mutual appeasement in black headed gulls. 6. Appeasement display of *Avocet*. 7. Nest relief ceremony of night heron

in the from of chemicals (scent displays) or in the form of a song (sonic displays). The author in 1975 recorded the importance and significance of sound production and stridulation among spiders and found that they may serve as a warning and threat to the predators (*Science Reporter*, Dec. 1975). The threat display in most animals serves to keep the intruder away. If, however, the intruder does not flee, a fight ensues. The threat serves to reduce the chances of actual fight. Sometimes animals do fight vigorously for the defence of the nest site, territory, mate, food, for deciding the social-rank or for some other biological reasons.

Appeasement displays

Too much of aggressive behaviour may disrupt the family or group life, as it may induce and compel weaker and submissive individuals to leave the group. Such weak individuals would be unsuccessful to live a normal life, as they are likely to fall a prey to predators and other environmental and competitive pressures. The aggressive behaviour would also affect the normal reproductive activities of the species and it would waste a lot of time and energy that could be put to better use for mutual cooperation and care of the young. Dr. S. A. Barnet (1963) of the Australian National University found that constant aggressive behaviour among rats grouped in a small enclosure keeps the individuals in tension and reduces the birth rate. Under these circumstances, it is very useful for the individuals of a particular species to perform such behavioural patterns that could reasonably reduce, inhibit, conceal or suppress unnecessary fighting at a specific time. Such behavioural patterns are called appeasement displays. The appease-



Figs. 8. Male gentoo penguin appeasing his mate. 9. Male lapwing displaying. 10. Appeasement display in Ruff. 11. Subordination appeasement in dog. 12. Dominance-subordination display in dogs

ment behaviour suppresses the escape tendency of the submissive individuals who can then continue to stay in the group without any serious harm or damage to themselves. Appeasement therefore has a great survival value for a species.

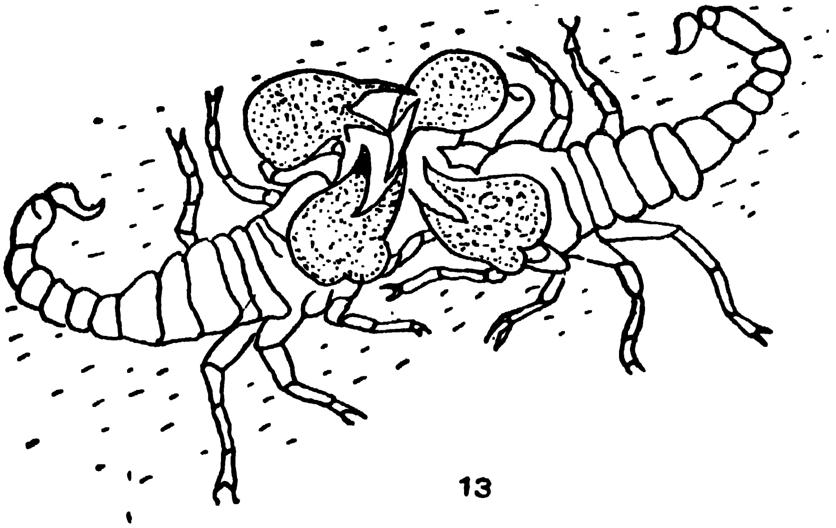
Appeasement display is shown by both the partners when they are equally aggressive. However, in most species, males are comparatively more aggressive than females. And hence it is necessary for the female to suppress the male's aggressive tendency. Similarly, the male has to appease the female when the latter is looking after the eggs and the brood.

The appeasement displays often become a part of the complex courtship behaviour in many animals. And it is thus difficult to recognize appeasement as a separate behavioural display during courtship. The courtship dance of many invertebrates (spiders and scorpions) serves not only to appease the mate and persuade her for mating, but it may also inhibit aggressive tendencies and unwillingness of the female partner.

Appeasement displays among the invertebrates have not been sufficiently understood. Studies reported are mostly on birds and mammals whose behaviour is easy to study in nature.

Appeasement displays in lower animals

Appeasement displays are not found in primitive groups of animals because they show simpler behaviour than the higher invertebrate groups. Among arthropods, many insects, spiders and scorpions, being aggressive, show appeasement behaviour, particularly during courtship. The male robberfly (*Proctacanthus*) presents his formidable mate with some food (a small insect) and mates



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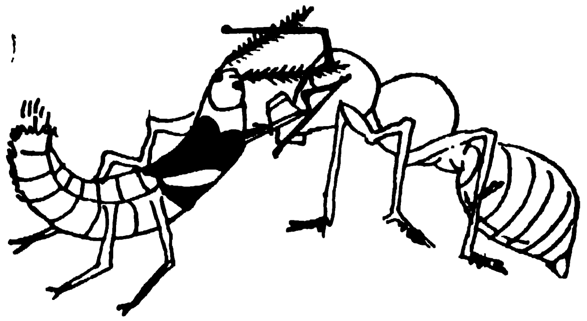

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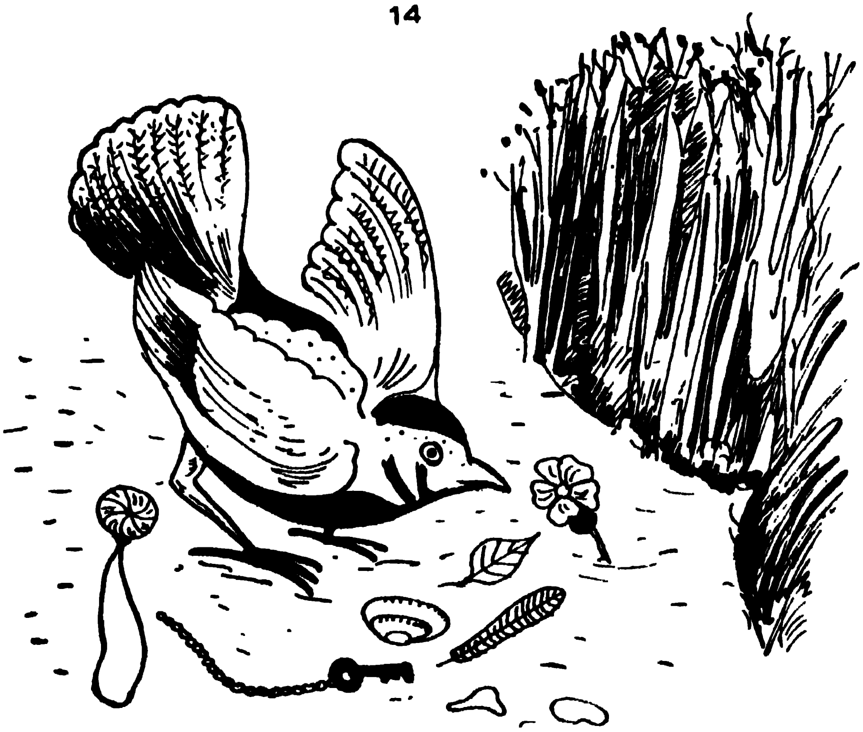

Figs. 13. Courtship dance in scorpions. 14. A Staphylinid beetle begging food from an ant. 15. The bower-bird, *Ptilonorhynchus violaceus*, on its display ground

with her while she is engaged in eating. Many social wasps, in which dominance behaviour has been recorded among the daughter queens, also show appeasement behaviour. Among spiders and scorpions, males approach females cautiously, prominently displaying coloured palps, legs or abdomen as in the British jumping spider, *Hasarius adansoni* (Fig. 1). The web-making spiders make special 'web pulls' to inhibit the females' aggressive and cannibalistic nature prior to mating. Male's courtship is, in fact, a signalling system designed to establish his identity and finally to immobilize the female so that he can mate with her. Similarly, scorpions are known to dance for a long time to appease the female and suppress her aggressive behaviour (Fig. 13). Those arthropods and other small animals that live in the nests of ants are called myrmecophilous animals. They commonly include small and very active beetles, thysanurans and crickets which are well-known for showing special care soliciting and food begging appeasement to their host ants (Fig. 14).

Appeasement displays in fishes and reptiles

In vertebrates, because of the territorial system, a male's first responses to a female may show elements of attack and escape behaviour in addition to those of sex. This holds true even when there is strong sexual dimorphism and the female is easily recognisable. Sometimes when the female is attacked, it does not flee but remains still and takes up an appeasement posture. The female in many species of fishes avoid attack from the more aggressive male by swimming underneath the male or by displaying swollen abdomen (containing eggs) to suppress the attack. During breeding season, the male three-spined stickleback fish (*Gasterosteus aculeatus*) performs a zig-zag dance to attract the female to the nest made by him.

The 'tail wagging' among the wall lizards (*Hemidactylus*) (Fig. 2) acts as an appeasement to suppress the aggressive tendency when they approach each other.

Appeasement displays in birds

Appeasement displays are best known among birds when they are unable to escape or when escape is disadvantageous. Among domestic fowl, a subordinate bird shows appeasement by lowering and retracting the head and neck (Fig. 3) against the threat display from a dominant bird. Among many birds, the appeasement display inhibits the attack by arousing a conflicting tendency in the attacker. During breeding season, it is common to find the female crow (*Corvus* sp). or gulls (*Larus argentatus*) resorting to infantile behaviour in the form of food begging (Fig. 4). It appears that this behaviour reduces the male's aggressiveness.

Among back-headed gulls (*Larus ridibundus*), appeasement is shown by both the sexes by turning the head away from each other (Fig. 5), up or down, hiding the bill or threat signal spot away from the opponent. The female *Avocets* attains a typical head down posture (Fig. 6) and repeats it several times to appease the male. This display indicates that she is ready to mate. A similar head down posture is observed during a 'group display' of *Avocets* in which all the members behave in a similar manner to greet each other.

Appeasement displays for relieving the partners of the nest are highly varied. An Austrian naturalist Dr. K. Z. Lorenz (1935) reported that when a night heron (*Nycticorax nycticorax*) returns to its nest, it makes a bow towards the inhabitants who (Fig. 7) may be its mate or its young, to exert friendly or parental intentions. In doing so, it shows off the beautiful bluish-black cap and raises the three thin white head plumes which at rest are folded together. After this introduction, it steps down into the nest and is received cordially without any attack.

The common house crow presents some nest material (a bit of twig or a wire, etc.) to his nest mate to relieve her of the nest. Sometimes, the male captures the young of other small birds or a mouse and presents it to the female by calling her aloud. The nest relief ceremonies of the herring gulls take the form of a 'mew call' or involve the presentation of a nesting material to the mate. The gentoo penguins appease the incubating partner by a characteristic bow (Fig. 8). The male lapwings (*Vanellus vanellus*) appease their mate by displaying white undersurface of the prominently raised wings which suppresses her aggressive behaviour (Fig. 9). The Ruff's (*Philomachus pugnax*) also display white undersurface of the wings to an aggressive female (Fig. 10). A similar appeasement behaviour has also been observed in the 'Sarus' cranes (*Antigone antigone*) found in northern India.

The bower birds (*Ptilonorhynchus violaceus*) appease the female by a more impressive method of building an attractive 'display ground' which the male decorates with rows of twigs, various coloured objects, flowers, stones, shells, parrot, feathers, fragments of glass, bits of crockery, rags, paper, charcoal and even silver coins, jewellery, car keys, etc., stolen from human habitations. The display ground has no connection with the nest which is built on a tree. The male displays by lowering the body and head with the tail and wings opened fan-like (Fig. 15). The female comes to the display ground and begins to rearrange the disordered twigs. The

"He says his studies on animal appeasement behaviour have greatly helped him to maintain a happy domestic life."

male runs excitedly forwards and backwards to appease the female.

In some birds, the female becomes dominant after pair formation. And the male's subsequent behaviour shows more overt signs of fear and he appeases the female.

Appeasement in mammals

Appeasement displays are common in wolves, baboons, monkeys, sheep, deer and cattle. As reported by Dr. K. R. L. Hall (1965), a subordinate baboon of either sex turns away from the aggressor and crouches in the sexual presentation posture. The dominant baboon accepts this behaviour as a gesture of submission and may even show temporary mounting behaviour. Among wolves (*Canis pallipes*), appeasement is displayed by a subordinate individual by turning its head away and facing the neck towards the dominant. Subordinate dogs may lie flat on the ground with abdomen facing the aggressor who may finally allow him to go unharmed. When the subordinate dogs do not have any chance to escape, they even allow temporary examination of their genitals after attaining a submissive posture.

The tail wagging and lowering of external ears in dogs is understood as a gesture of friendship and submissiveness. If one observes carefully, tail wagging is a special display by the male dog when proposing to a female. But the female may show unwillingness by displaying her teeth and facial expressions. In the domestic cat aggressive behaviour continues even during courtship. The female fights furiously with the appeasing and courting male which remains submissive during courtship for a long time and finally succeeds in suppressing her aggressiveness and arousing sexual receptivity in her.

Among dogs and wolves, and possibly in many other animals, the tail plays an important role not only in appeasement but also in displaying the social-rank and status of the individual. A dominant animal keeps its tail distinctively raised and coiled over the trunk (Fig. 12), but the one with a lower rank keeps its tail hanging or by the side of the leg. In the extreme case of subordination, the animal tucks its tail in between the hind legs in close contact with the abdomen (Fig. 11), a behavioural feature also found in the pups. These behavioural patterns originally devised for a particular situation or purpose are frequently used in different circumstances.

Mutual licking of the body in certain mammals should be considered as an appeasement display of a high order. The cow licks the bull to suppress his aggressiveness and induce sexual behaviour in him. Soon, they enjoy mutual licking. This kind of appeasement is similar to mutual preening in birds and mutual grooming in monkeys.

It is interesting to see how human beings with their power to reason have evolved similar ceremonies. Greetings often has the function of appeasement and to suppress aggressiveness and related reactions.

One is impressed by studying appeasement displays that are used for different functions, viz., communication, individual survival and mutual cooperation among members of a species. Appeasement provides not only chances of survival but also better adaptability and mutual understanding.

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SCIENCE SPECTRUM

Moons of Mars

"1, 2, 4.. is a harmonious series and the Creator of this universe always does things in complete harmony," so thought that great astronomer Johannes Kepler about three centuries ago. If earth has one satellite, Moon, and Jupiter has four (till then discovered), he argued, the planet Mars in between should have two satellites. This logic though subsequently was voiced by Jonathan Swift and Voltaire, it remained only a logic until 1877 when Asaph Hall of U. S. Naval Observatory, Washington, U. S. A., discovered the satellites simultaneously. Owing to his fancy to Roman pantheon, he called them after the two charioteer sons of Ares—Phobos (Fear) and Deimos (Terror). The reason why he attributed to these innocent chunks of matter these fright-giving names is not known. Notwithstanding the recent Viking landings on Mars, these so-called moons are still a mystery to astronomers and scientists.

Much smaller than our Moon, these satellites have an equally insignificant place in the sky of Mars. While Deimos, the smaller and less rugged of the two, assumes as much brilliance as that of Venus in our sky and takes much time to move from horizon to horizon, Phobos, though closer to Mars, is bright no more. It is only quicker—it crosses the Martian sky within a few hours. As their plane of orbit around Mars is the same as that of its equator, they cannot be viewed from the polar regions or at higher latitudes of this planet.

A glance at these moons will (Figs. 1 and 2) convince any one that they are irregular in shape. However, they are in fact ellipsoidal if we ignore a few spallings of big chunks found here and there on their surfaces. Moreover, as expected, they both turn their one face always towards the Mars, just as our Moon does. However, they have a greyish colour tinge unlike the pinkiness of Mars. Besides some differences between them (Table. 1) which do not need further elaboration, factors such as craters, regolith and their origin need discussion. (*Scientific American*, Feb. 77)

Craters and regolith

Like our Moon, the Martian satellites too abound in craters, though they are a bit different. Owing to the very low gravity as compared to that of Moon, the craters here do not possess central peaks and blankets of ejected debris. In addition, it has been found that the craters on these moons have sharp edges. What could be the reason for their being so ? One possibility is that these moons had formed along with the solar system and are not simply chunks of loose rubble which had got coalesced due to gravitational forces. In other words, they are of solid rock. Another plausible inference from this type of craters is that the process of cratering on these satellites may have been somewhat different. Laboratory experiments were conducted to probe into this aspect of cratering. It was found that when low-energy small bodies collide a small body,

Table 1

Characteristics	Phobos	Deimos
Orbital period	7.7 Hours	2.4 Hours same as of Mar's rotation
Present estimated principal diameters	27, 21, 19, km.	15, 12, 11 km
Largest crater (size in brackets)	Stickney (10 km) Hall (6 km)	Voltaire (2 km) Swift (1 km)
Overall reflectances (compared to moon 11%)	6%	
Orbital acceleration	0.001 degree/year /year	Not yet observed

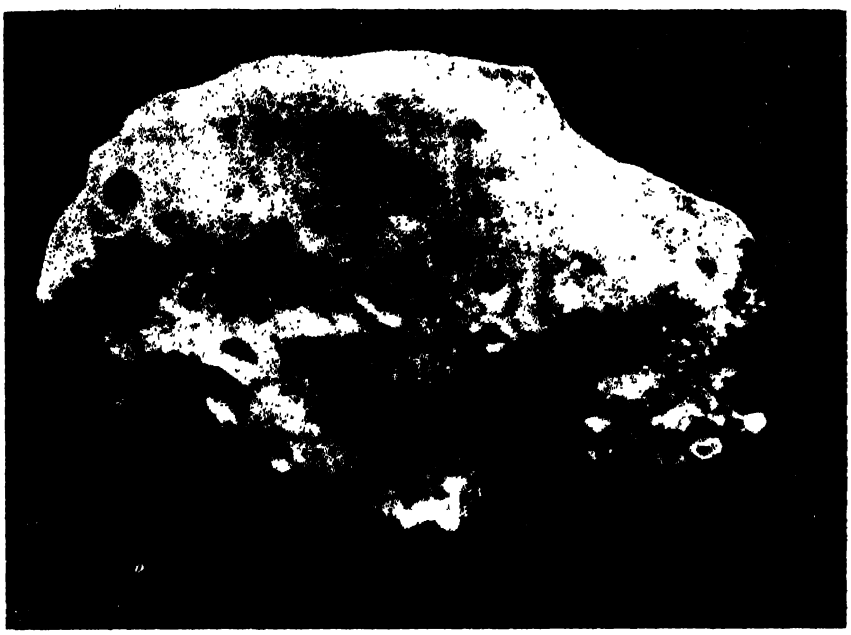

Fig. 1. Phobos

craterlike scars, are produced on the surface of the target with the maximum damage done at the contact area. On the other hand, if high-energy small bodies collide a small target body, spalling of matter takes place on the point exactly opposite the contact-surface of the target. Sometimes, such spalling causes the target to shed its outer layers exposing the inner solid core. Ordinarily, of course, spalling produces sharp edges in craters.

Regolith is a powdery layer found evenly on the surface of bodies. The two moons observed optically and thermally have been found to possess this layer. It has been found that this layer is dark in colour and has light-absorbing properties, besides being of low conductivity. As to how such small bodies with so low a gravity are able to retain this layer has stimulated astronomers, and researches are in progress to solve the puzzle.

The most accepted and appealing explanation forwarded to explain the layer's presence is the one based on the finding that the debris ejected by high energy impacts (which produced the craters) is of a wide range of velocities. Some debris whose velocity is less than the escape velocity of moons (the velocity required by a body to escape from the gravitational pull of the moons) fall back and are collected on their surfaces. The only moot point in this explanation is that whether the debris would cover the entire surfaces of the moons as it has in the form of of regolith. The laboratory experiments on this issue do not give a conclusive proof.

The Viking orbiters which scanned the surface of Phobos tell a different story. The craters produced on this moon, according to their investigation, are mainly due to bodies thrown away by Mars when cratered by an interplanetary body. It could thus be generalised that as the two moons are quite close to Mars, they act as dustbins—collecting the debris thrown by it. Say, for instance an interplanetary body craters Mars and debris it throws away doesn't possess much velocity as required to escape from it. What naturally follows is that the debris gets into the planet's orbit and is eventually captured by either of the moons. There is also a strong possibility that the debris ejected by the moons themselves may not have enough velocity to overcome

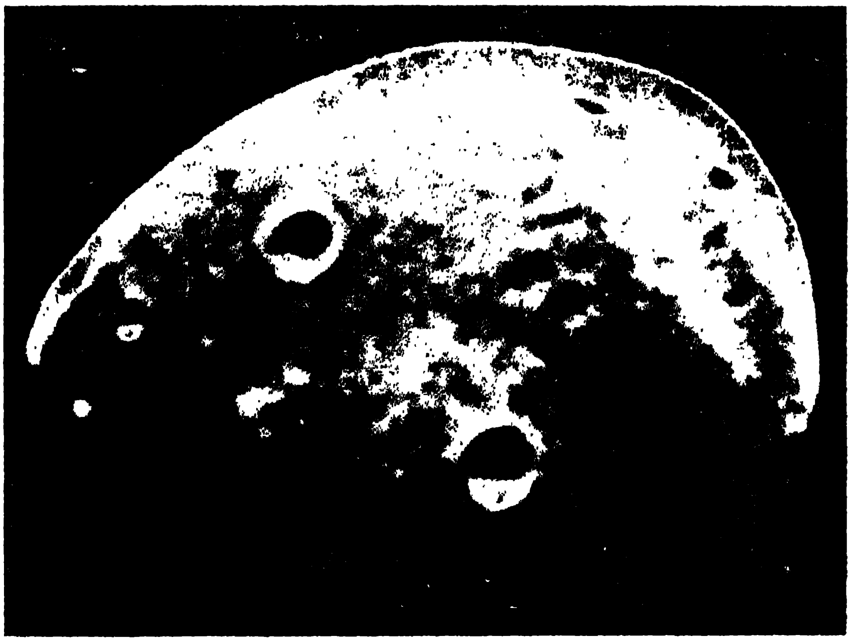

Fig. 2. Deimos (*Courtesy U.S.I.S*)

the planet's pull which dominates all forces there. So the moons, in this manner, are able to retrieve their own debris.

Origin

There is no conclusive evidence yet that may suggest a clearcut source of origin of the two moons. Moreover, two questions arise in this case. The first is whether they have a common source of origin or not. Secondly, whether that source is Mars or some outside body. The similarity in the orientation of their orbits and some inadequate photometric characteristics suggest that they have a common origin. Taking this for granted, let us see how they might have been formed and where.

One straightforward theory is that they might be two chunks which formed out of coalescence of matter left over after the birth of Mars in the solar system The spin imparted to them may be due to a violent impact with a large interplanetary body. The violence of the spin must have been toned down by the counteracting tidal friction, which, quite inevitably, brought the moons in synchronous orbit of the planet. The rival theory which attributes the origin of these moons to a catastrophe has, however, been argued on the basis of indirect evidences.

There are enigmatic grooves on Phobos whose origin and nature is still not clear. It could only be guessed, and mind it, this guess is an exciting possibility. A phenomenon called layering, in which lava successively flows on the surface of a body, took place aeons ago on this moon. As such a process, which also includes melting and differentiation, takes place only on a large body, this moon, or both the moons, for that matter, must be fragments of that parent body. It is possible that once there was a large moon of Mars which, on a catastrophic collision with an outside body, broke into fragments, of which only two big ones survived. Or, it is possible that Mars had captured these bodies from the nearby asteroid belt (a swarm of small bodies between the orbits of Mars and Jupiter). Or, a large asteroid had, on its passage by the Mars, somehow got broken down to form the two moons. Besides the fact that the probability of happening of these phenomena is low and otherwise technically unexplainable, the crucial point is how the orbits of the moons ended up in the equatorial belt of the planet.

The Vikings presently on the Mars will narrow down the question of the origin to a certain extent. They will ascertain densities of these moons and from this investigation origin could be settled. If the densities come roundabout 2.9 gm/cc the material of the moons is basaltic. Such a material could only be formed on a large body. On the other hand, if densities come roundabout 2.3 gm/cc the material is then carbonaceous chrondites. Not necessarily a large body forms this type of material. The moons then could be taken as the left over remains of Mars or they could be the "refugees" from the asteriod belt. Let us await the Viking results.

But why do we study these small bodies, after all? It is because in size they are equal to the bodies in the asteriod belt and elsewhere in the solar system. The characteristics of these small bodies, for example, weak gravity, absence of atmosphere, etc., are also identical. So by studying the moons of Mars we can ascertain what processes were at work at various corners of the solar system that formed the bodies.

DILIP M. SALWI

Man-made causes of climatic changes

MAN-made pollutants not only damage environment, health, vegetation and materials, but also interfere with climate.

Climate can be defined as the synthesis of weather. Several complex processes determine the nature of the climatic energy system. Variations of climate were reported between 1900 and 1940 when there was a general warming of the northern hemisphere due to increased carbon dioxide concentration. High particulate matter was taken as a cause for partial global cooling between 1945 and 1970.

The present atmospheric background concentration of carbon dioxide is 330 ppm by volume which is higher by 10% over the quantities in many earlier millennia. A 14% rise reported in Hawai and South Pole between 1958 and 1974 is related to 'Southern oscillation', an atmospheric phenomenon alternating biennially. Climatic shift occurs in some continents as a result of a slow wandering of the poles due to a continual axial rebalancing of the earth. The earth's body slowly oscillates annually within 12 cm to a new position while the axis remains aligned to the celestial sphere.

More than half the carbon dioxide generated by the combustion of fossil fuel persists in the atmosphere. The rest is taken by the oceans and biosphere (which could be defined as that part of the earth where life exists). It is something like a terrestrial envelope where liquid water exists substantially. It gets an abundant supply of energy from the sun. The interfaces of the three primary states of matter—solid, liquid and gas—coexist in it.

Currently, the energy of solar radiation enters the biological cycle only through the photosynthetic production of organic matter by chlorophyll-bearing organisms. They include green and purple bacteria, blue-green algae, phytoplankton and the vast population of higher plants. The organisms are limited to that part of the biosphere which receives solar radiation by day.

The dynamic state of transformation and utilisation of carbon dioxide is maintained through the ability of ocean phytoplankton and plants on land to capture sun's energy which photosynthetically converts CO_2 into useful organic molecules. But the dynamic equilibrium among the major reservoirs of carbon dioxide in the biomass, atmosphere, hydrosphere and soil is continuously being disturbed by man.

With a 4% annual increase of fossil fuel consumption the atmospheric CO_2 will reach 400 ppm by the end of the century. An eightfold increase is likely in the next two hundred years if the CO_2 absorbed by the ocean is disturbed by the ecological imbalance resulting from man's misuse of global resources.

What could be the possible effect of such an increase? Models show that a doubling of CO_2 in atmosphere leads to an average surface temperature rise of 2.5°C resulting in cloudiness and precipitation. Increased cloudiness reduces incoming solar radiation, counteracting warming and increased sea-surface temperature reduces CO_2 uptake which enhances warming. Increased carbon dioxide leads to its greater absorption by oceans making them more acidic. Their biological productivity and albedo are consequently altered.

Pollutant particulate matter is not only a human health hazard, but modifies climate also. Aerosols disturb the atmospheric heat balance. They absorb and scatter shortwave solar and longwave infrared terrestrial radiations.

Table 1. Estimate of tropospheric aerosol production rates

Source	Emission (10^6 metric tonnes/year)
Natural	
Soil and rock debris*	100-500
Forest fires and slash-burning debris*	3-150
Sea salt	(300)
Volcanic debris	25-150
Particles formed from gaseous emissions:	
Sulfate from H_2S	130-200
Ammonium salts from NH_3	80-270
Nitrate from NO_x	60-430
Hydrocarbons from plant exudations	75-200
Sub-total	773-2200
Man-made	
Particles (direct emissions)	10-90
Particles formed from gaseous emissions	
Sulfate from SO_2	130-200
Nitrate from NO_x	30-35
Hydrocarbons	15-90
Sub-total	185-415
Total	958-2615

*Includes indirect contributions from man-made emissions

The total annual emission of particulate matter into the biosphere from sources like soil and rock debris, forest fires, sea salt, volcanic debris, etc., is about 800 million metric tonnes. Man-made particles and gaseous emissions of sulphate, nitrate and hydrocarbons account for an additional 400 million tonnes per year (Table 1 gives details). The aerosols stay in the troposphere for a maximum of a week or ten days, the highest concentrations of the suspended particulate matter occurring within a 1000 km perimeter around the source.

In the belt around 30°N to 70°N in the northern hemisphere, atmospheric concentrations of suspended particulates are increasing. Places far away from cities in the USSR show 10% less of normal surface radiation in the last two decades. Due to the southerly flows a polluted air from eastern United States, summer haziness has increased in Eastern Canada. High concentrations of particulate matter are reported in the urban air of Eastern and Central United States. In India high particulate matter concentrations have been reported from the urban industrial conglomerates of Calcutta, Madras and Bombay.

How do suspended particles affect the atmosphere's radiative balance? Due to interception, the quantum of solar radiation reaching the ground is reduced and the 'green house' effect of the atmosphere is enhanced due to terrestrial radiation. It has been worked out that a doubling of present aerosol concentration reduces temperature by 1 to 3°C. The magnitude and nature of the temperature change depend on the composition and concentration of aerosols, their particulate size distributions, humidity, etc.

Thermal pollution from industrial processes, space heating and power generating stations affect climate. Local climatic modifications are well-known in urban heat islands due to anthropogenic heat emissions. Some city temperatures exceed that of neighbouring rural areas by 1°C to 2°C, and night temperature differences are even higher. When winds are light, the urban wind quantity becomes worse. In heavily populated areas like New York and Calcutta, man-made heat input can exceed solar heat input especially in winter.

Heat released from urban and industrial conurbations and power parks may affect global weather. A 40000 MW nuclear power park initiates and augments convective clouds and precipitation over the source region, causing increased ground fog within 100 kms of cooling towers and significant persistence of water vapour plumes.

Many pollutants affect the natural balance of the stratosphere. The stratospheric ozone layer with a central mass is at a height of 20 km from earth's surface. Its effects are well-known on stratospheric radiation balance and atmospheric general circulation. It shields man from carcinogenous solar ultraviolet radiation. A 1% ozone reduction can raise the incidence of human skin cancer 2%.

A multiplicity of reactions is involved in the maintenance of the fragile ozone layer of the stratosphere. Many anthropogenic inputs can catalyse reactions which destroy ozone. They include supersonic aircraft emissions, oxides of nitrogen, debris from nuclear bombs, chlorofluoromethanes from aerosol sprays, refrigerants, etc. The latest generation of computers has given the interactive and dynamic effects of several stratospheric photochemical reactions.

According to the World Meteorological Organisation, a large fleet of supersonic aircraft flying 17 km above earth's surface will affect noticeably the ozone layer. If chlorofluoromethanes continue to be emitted at the present rate, 10 % depletion of ozone layer may possibly occur.

Krypton-85 with a half life of 10.7 years is a pollutant emitted from nuclear power stations. It is projected that it could raise the electrical conductivity of the lower atmosphere by 15% in the next half century. Consequently, variations are likely to take place in thunder cloud electrification altering precipitation processes and modifying climate.

International and intercontinental research programmes are needed on a large-scale for studying the anthropogenic emissions which affect climate. Climate and weather have been major causes of the birth, growth and destruction of the civilisations of the world. The numerous conditions determining climate are interlinked intricately depending on the dynamics of the biosphere and the photochemistry of the stratosphere. Regional scale buildup of pollutants may also become substantial enough to affect local weather systems. Hence short and long-term plans are needed for study of man's impact on climate.

S. SUNDARAM

Van Allen radiation belts

THE origin, nature and the composition of energetic cosmic rays, the stream of high energy subatomic particles which are now supposed to be coming from interstellar space, are still under discussion and are to be answered satisfactorily. Scientists, therefore, measure the intensity of cosmic radiation at various altitudes in the upper atmosphere with Geiger counters installed in balloon's and artificial satellites. In 1958 the consequence of one such cosmic ray study led to the discovery of a belt of electrically charged particles surrounding the earth called Van Allen belt. It is so called because it was first discovered by James A. Van Allen, Chairman of the Department of Physics and Astronomy at the State University of Iowa, USA. *Explorer-I* (February 1958), the first US satellite designed to measure the corpuscular radiations at high altitudes, showed an exceedingly large counting rates, about 100,000 counts per second, in a region located at ±40 degrees latitude and at an altitude of 2500 km, in contrast to the expected 30 counts per second observed in the surrounding regions in the earth's sphere of influence. These observations indicated the existence of a localized region near the equatorial plane where enormous electrically charged particles were being temporarily trapped by the geomagnetic field of the earth. Another zone of such trapped charged particles has been discovered by lunar probe *Pioneer III* (December 1958) during its unsuccessful moon flight.

Ever since the discovery of these belts, scientists and astrophysicists worldover have been interested in studying the nature, composition and origin of these belts. They launched many artificial satellites for this purpose. The extensive search manifested the overall picture of the radiation belt. It extends to an altitude of roughly 90,000 km and contains two

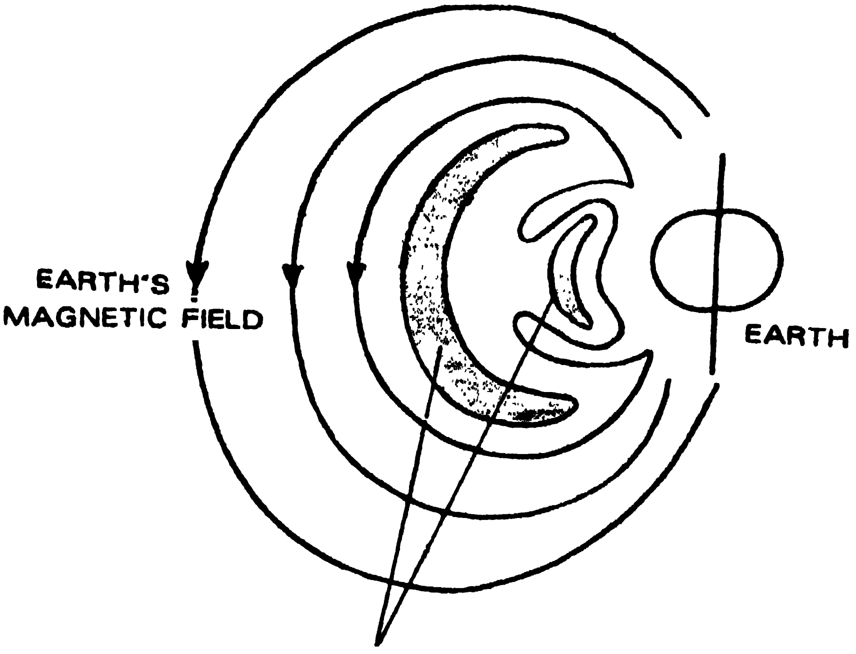

Fig. 1. Van Allen Radiation belts

localized zones called 'inner' zone and 'outer' zone. The zones are distinct and are separated by a region called 'slot', where the radiation intensity is normal, as expected due to the all pervading cosmic rays. Each zone could be imagined as approximately a spheroidal figure drawn about the magnetic axis of the earth. These belts wobble up and down as the earth spins, as the magnetic axis of the earth is tilted about 11 degrees to its axis of rotation.

What is the origin of these belts? The all pervading cosmic radiation could be the source of the particles that comprise the belts. The charged particles in these belts, which have a wide range of energy, spiral around the magnetic lines of force of the earth in large loops. They bounce back and forth from one polar region to the other in only a few seconds. Very high energetic particles which are not constrained may either leak into the atmosphere or be thrown into space. As the particles move along the lines of force, they drift around the earth. Trapped electrons drift to the east, protons to the west, and as a consequence of their drift, a westward flowing electrical current is established.

The overall view of the intensity structure of the two principal radiation zones is shown in Fig. 1. The observations with satellites demonstrate conclusively that the nature of these zones is quite different from each other. The inner belt extends from 40 degrees northern to 40 degrees southern latitude, while the outer belt extends to a still greater extent. They are toroidal (doughnut shaped) in structure. Recent geophysical discoveries with artificial satellites tell the following facts about Van Allen belts.

The intensity of charged particles in the inner zone is maximum at a distance of about 5×10^3 km from the surface of earth. The energy measurement of the trapped particles in the inner zone indicates that it has two components: high energy proton, the energy of which is of the order of 100 MeV, and low energy electron, the energy of which is of the order of 1 MeV. Joule is too large to represent the energy of this type. In physics of microworld, an unit MeV (million electron volt) is frequently employed. One MeV of kinetic energy is that quantity of energy acquired by an electron in passing through a potential difference of 10^6 volts and is equal to 1.602×10^{-13} joule.

The intensity of the charged particles in the outer zone is maximum at a distance of about 2×10^4 km from the surface of the earth in the equatorial plane. Its outer limit extends upto 9×10^4 km. The constituents of outer zone are exclusively low energy electrons. Energy measurement shows that the upper limit of energy of these electrons is of the order of 0.1 MeV.

The intensity of charged particles in the inner zone remains quite steady, while in the outer zone it fluctuates. These fluctuations are apparently associated with solar flares. During a solar flare, the sun emits a large quantity of ionized gases in a violent explosion on its surface. Since the nature and characteristics of the trapped particles in the two zones are quite different, it is strongly believed that they might originate from different sources. It is claimed that the high energy protons in the inner zone may be due to galactic and solar cosmic rays. The rapid changes in the intensity of radiation of outer zone indicate clearly that it has an abundant and changeable source. As the intensity of the energetic electron is more intimately related to solar flares, it is hoped that sun is responsible for the origin of the outer belt.

Later studies of such radiation belts confirmed that they are present around all celestial bodies which have a magnetic field.

It is impossible for a living creature to pass through these deadly radiation belts and remain alive. So the presence of Van Allen radiation belts around the earth presents a hurdle to interplanetary space travel. The energetic radiations from these belts are injurious to astronauts and cosmonauts. Further, they cause serious radiation damage to transistors and other sophisticated equipments aboard a satellite, reducing their output considerably.

By creating an intense magnetic field, the penetration of energetic radiation through the spaceship can be prevented. But the biological effects of such intense magnetic fields have not yet been studied. One way of evading the radiation belts is to launch a rocket through the polar region, as the polar region is quite free from charged particles. These regions are called corridors and are the only routes for an unimpeded access to outer space

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About linear programming

WHAT is Linear Programming? Linear Programming is a method of finding an optimal solution to some real life problems, which can be formulated in a mathematical form consisting only of linear relations. Many types of managerial, transportation, warehousing, economic problems, etc., belong to linear class. In all these problems, there will be more unknowns than there are equations, and so there will be more than one set of solutions for the unknowns. LP method offers a powerful tool for finding the optimal solution under such conditions and arrive at decisions on a scientific basis.

A typical LP problem

Let us consider the following problem and see how the LP method can be applied to it. A firm produces two types of dolls, say, A and B. The profit on the doll A is Rs. 8/- and the profit on the doll B is Rs. 6/-. Each doll requires two operations in making it, namely, assembling and painting. The assembling time for the doll A is 2 hours and for the doll B is 3 hours. The painting time for the doll A is 2 hours and for the doll B is 1 hour. The periods available for assembling and painting per day are 10 hours and 6 hours respectively. For maximum profit how many of each type of doll should the firm make every day, if they can sell all that they can make.

The mathematical model of the above real life problem is given as follows: Let the firm make x_1 dolls of type A and x_2 dolls of the type B. The time restriction for assembling per day gives us the relation

$$2x_1 + 3x_2 \leq 10 \quad \text{... (1)}$$

The time restriction for painting per day gives us the relation

$$2x_1 + x_2 \leq 6 \quad \text{... (2)}$$

The total profit is given by

$$P = 8x_1 + 6x_2 \quad \text{... (3)}$$

Since x_1 and x_2 cannot be negative, we get the restrictions

$$x_1 \geqslant 0 \text{ and } x_2 \geqslant 0 \quad \text{... (4)}$$

The inequalities (1) and (2) are called the constraints, and the function (3) which is to be optimised is called the objective function. The restrictions given by (4) are called the non-negativity restrictions. The problem is to find out for what values of x_1 and x_2 (satisfying the restrictions 1, 2 and 4) the profit 'P' is maximum. That is, the expression $(8x_1 + 6x_2)$ must be maximised, subject to the restrictions 1, 2 and 4. Any set of x's which satisfy the constraints is called a solution of the LP problem. Any solution which satisfies the non-negativity restrictions is called a feasible solution. Any feasible solution which optimises the objective function is called the optimal feasible solution.

In cases where there are only two unknowns, the problem can be solved graphically as follows. Draw the line AB ($2x_1 + 3x_2 = 10$) on a graph as shown in the Fig. 1. All points on the line AB and below it inside the positive quadrant satisfy the constraints (1) and (4). Draw the line CD ($2x_1 + x_2 = 6$) on the same graph. All points on the line CD and below it in the positive quadrant satisfy the constraints (2) and (4). The area OAED, which satisfies all the constraints, represents the area of feasible solutions and has been shaded in the figure. We have to choose a value of P which would maximise (3) and still lie in the area of feasible solutions. Obviously the line which maximises P would be one which has at least one point in the zone of feasible solutions. In several situations there may be many optimum values, but in the above case it can be easily shown that the point of intersection of the two lines AB and CD gives the values of x_1 and x_2 for which (3) is maximum, i.e., when $x_1 = 2$ and $x_2 = 2$. Thus, in one day the firm must make two dolls of type A and two dolls of type B to earn maximum profit.

The above graphical method suggests that the solution to such problems can be obtained by putting equality signs in the constraint equations 1, 2 and 4. The various feasible solutions are then obtained by solving two equations at a time and the best solution which maximises the objective function is obtained by actual substitution of the different sets of values. By converting the constraint equations into exact relations we get the following four equations:

$$x_1=0 \quad .. \quad (5)$$

$$x_2=0 \quad .. \quad (6)$$

$$2x_1+3x_2=10 \quad .. \quad (7)$$

$$2x_1+x_2=6 \quad .. \quad (8)$$

To get all possible values of x_1 and x_2 the equations are solved by taking two at a time. Since there are four equations, there will be 6 combinations, namely, (5 & 6), (5 & 7), (5 & 8), (6 & 7), (6 & 8) and (7 & 8) when taken two at a time. The solutions of these sets of equations are given in the Table 1. The last column tells us which of these solutions are feasible. Feasible solutions are those which satisfy the constraints 1, 2 and 4.

We see that there are four sets of feasible solutions and now we have to find the optimal feasible solution. This is done by substituting each set of feasible solutions in the objective function (3) and finding the values of P. Table 2 gives the values of P for the different sets of feasible solutions.

Table 2

Sets of feasible values of x_1 & x_2	Values of P
0, 0	0
0, 10/3	20
3, 0	24
2, 2	28

It is seen that $x_1 = 2$ and $x_2 = 2$ are the optimal solutions, since they give the maximum value for P. We also see that the optimal solution lies at the intersection of the boundary of the set of feasible points.

It may be noted that if the problem is a 3 variable problem, the equations must be solved three at a time, and the same procedure is followed to find the optimal solution from the set of feasible solutions.

Simplex method. The graphical and the calculation methods described above may be suitable if the number of variables are two or at the most three. If the variables are more, the problem can be tackled by the Simplex method or the Tableau method. Suitable algorithms exist for this Simplex method which can be easily programmed for getting a computer solution. This method enables one to make what is called the sensitivity analysis, which is very important in many types of LP problems.

Whenever we have an inequality, we know that by adding proper non-negative number to the smaller side, we can make both the sides equal. Such non-negative numbers added to the smaller side are called the slack variables. The inequalities (1) and (2) are converted into equalities by adding the correct quantities y_1 and y_2 to the left sides and written as

$$2x_1 + 3x_2 + y_1 = 10 \quad .. \quad (9)$$

$$2x_1 + x_2 + y_2 = 6 \quad .. \quad (10)$$

We have the objective function as

$$P = 8x_1 + 6x_2 \quad .. \quad (11)$$

The actual coefficients of x_1, x_2, y_1 and y_2 of equations (9) and (10) are written in the tableau form in two rows. An extra row is written below, which contains the negatives of the coefficients of the objective function with the value of constant term as zero. The following is the tableau.

$$\begin{array}{ccccc} x_1 & x_2 & y_1 & y_2 & \text{constant term} \\ \end{array}$$

$$\begin{pmatrix} 2 & 3 & 1 & 0 & 10 \\ 2 & 1 & 0 & 1 & 6 \\ -8 & -6 & 0 & 0 & 0 \end{pmatrix}$$

Ratio of
constant/x_1
5
3

Step 1. Select the highest numerical -ve value in the third row which is called the control row. The vertical column above this number is called the pivotal column. In the above case, the first column is the pivotal column. Then the pivotal row must be found as follows. From the ratio of the constant to the +ve elements of the chosen column as given at the right ends of the tableau or the matrix. The row corresponding to the lowest value of this ratio defines the pivotal row. In the above case, the second row is the pivotal row. Divide the pivotal row by the term in the pivotal column. We get the following matrix or the tableau.

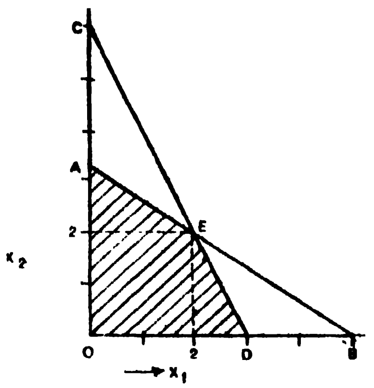

Fig. 1

$$\begin{pmatrix} 2 & 3 & 1 & 0 & 10 \\ 1 & \frac{1}{2} & 0 & \frac{1}{2} & 3 \\ -8 & -6 & 0 & 0 & 0 \end{pmatrix}$$

Step 2. Now we have to make elementary transformations to make all the elements in the pivotal column zero except the one in the pivotal row, whose value is 1. For each other row in the matrix, multiply the new pivotal row by the element in the pivotal column and subtract the result from the row being changed. Do this for every row in the tableau, including the

Table 1

Combinations of equations	x_1	x_2	Feasible or not
5 and 6	0	0	Yes
5 and 7	0	10/3	Yes
5 and 8	0	6	No
6 and 7	5	0	No
6 and 8	3	0	Yes
7 and 8	2	2	Yes

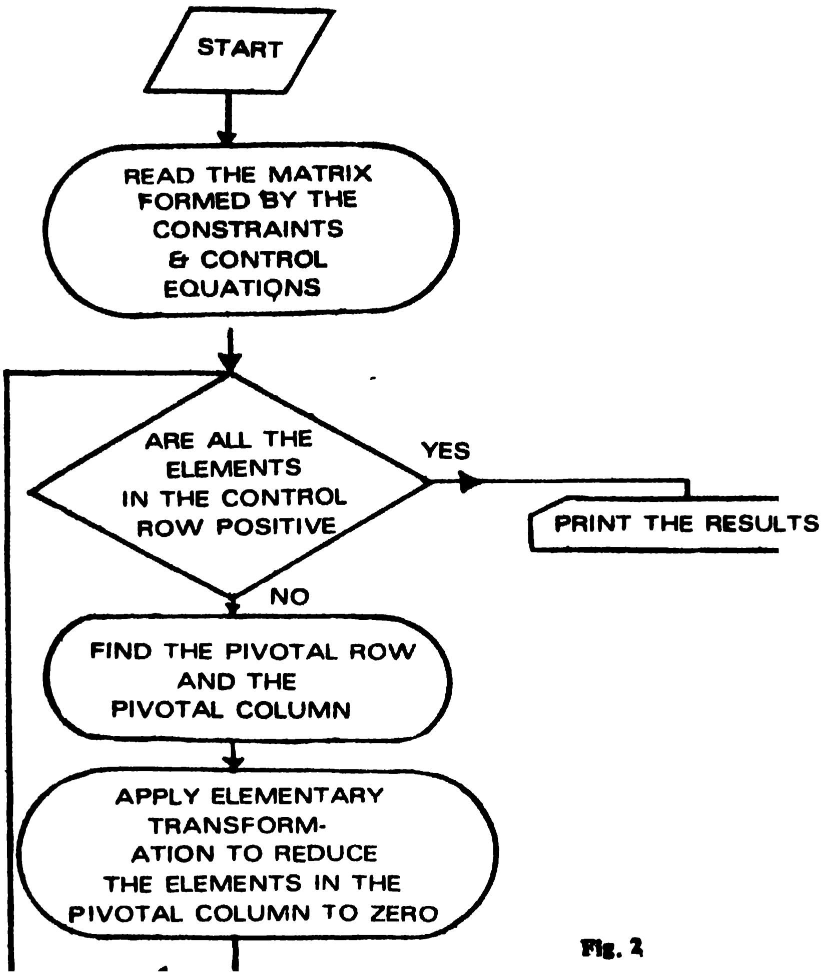
START
READ THE MATRIX FORMED BY THE CONSTRAINTS & CONTROL EQUATIONS
ARE ALL THE ELEMENTS IN THE CONTROL ROW POSITIVE
YES
PRINT THE RESULTS
NO
FIND THE PIVOTAL ROW AND THE PIVOTAL COLUMN
APPLY ELEMENTARY TRANSFORMATION TO REDUCE THE ELEMENTS IN THE PIVOTAL COLUMN TO ZERO

Fig. 2

control row. To reduce the first element in the pivotal column to zero value, multiply row 2 by 2 and subtract it from row 1 and write the new matrix as

$$\begin{pmatrix} 0 & 2 & 1 & -1 & 4 \\ 1 & \frac{1}{2} & 0 & \frac{1}{2} & 3 \\ -8 & -6 & 0 & 0 & 0 \end{pmatrix}$$

To reduce the third element in the pivotal column to zero value, multiply row 2 by—8 and subtract it from row 3, and write the new matrix as

$$\begin{pmatrix} 0 & 2 & 1 & -1 & 4 \\ 1 & \frac{1}{2} & 0 & \frac{1}{2} & 3 \\ 0 & -2 & 0 & 4 & 24 \end{pmatrix}$$

Step 3. Now examine whether there are still negative values in the control row. If so repeat the process by finding the pivotal row and the pivotal column for the above matrix. The second column of the control row of the above matrix contains the highest negative number and so this is the pivotal column. Form the ratio of the constant term to the x_2 value in the first two rows and find out for which row this value is minimum. Obviously it is minimum for the first row and so the first row is the pivotal row. Divide the pivotal row by the term in the pivotal column in the same row. Divide the pivotal row by the term in the pivotal column in the same row. That is, divide the first row by 2 and write the new matrix as

$$\begin{pmatrix} 0 & 1 & \frac{1}{2} & -\frac{1}{2} & 2 \\ 1 & \frac{1}{2} & 0 & \frac{1}{2} & 3 \\ 0 & -2 & 0 & 4 & 24 \end{pmatrix}$$

Again we have to make elementary transformations to make all the elements in the pivotal column, zero except the one in the pivotal row, whose value is 1. Multiply row 1 by $\frac{1}{2}$ and subtract it from row 2. Again multiply row 1 by —2 and subtract it from row 3. After performing the above two operations we get the final tableau as follows.

$$\begin{pmatrix} 0 & 1 & \frac{1}{2} & -\frac{1}{2} & 2 \\ 1 & 0 & -\frac{1}{4} & \frac{3}{4} & 2 \\ 0 & 0 & 1 & 3 & 28 \end{pmatrix}$$

Step 4. Now examine whether there are still negative values in the control row. The linear program has been solved when there are no negative numbers in the control row. The above tableau has no negative numbers in the control row and hence it is the solution tableau. The elements of the last column give the values of x_1, x_2 and P as 2, 2 and 28 respectively. That is, the firm must make two dolls of type A and two dolls of type B per day to earn maximum profit. The maximum profit is given by the last element, 28. This is of course a simple problem where the results are read as above, but this can be taken as the general procedure for all LP problems. The other elements of the final tableau have got significance in making what is called the sensitivity analysis. Readymade programs for this Simplex method are available at computer centers and one has only to formulate the problem in the mathematical form and supply the data cards in the correct format to the computer.

Physical meaning of the above matrix operations. It is very difficult at this stage to present the theory of the Simplex method, but it is enough if we know that this is a very powerful method and it works admirably well in LP problems. We have seen that there are many feasible solutions for LP problems and our aim is to find the optimal feasible solution. The elementary transformations followed in the Simplex method simply move from one feasible solution to another feasible solution until the optimal solution is obtained. The optimal solution is obtained when there are no negative elements in the control row. There are also special rules for reading the solution from the final tableau. The flow chart showing the procedures to be adopted in the Simplex method is shown in Fig. 2.

The greatest bugbear is the formulation of the problem, and once the LP problem is formulated, the computer will take care of all our other difficulties and give us a hopeful soluion.

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Satellite DNA

DNA isolated from a wide variety of organisms has been shown to give one or more additional sharp unimodal bands in CsCl beside the main DNA band. The minor component which bands at a different position from the main band DNA is called satellite DNA, a term which has only an operational significance. The definition of the term does not exclude the possibility that there may be more than one kind of native DNA molecule sharing the same property of banding together in CsCl. Also in the satelittle band there may be some low molecular weight DNA which does not band sharply in the analytical ultra centrifuge. The amount of satellite DNA may vary from 0.01%-40% of the bulk DNA.

It would be befitting to quote P.M.B. Walker of the University of Edinburg (Scotland) who remarks about the word Satellite in the following manner :

"In the political and astronautical period it was perhaps inevitable that these minor fractions should be called 'Satellite' DNA. It is an unfortunate term because it engenders confusion with satellite chromosomes, because many analogous DNA fractions have recently been found concealed within the main band DNA in CsCl gradient, and because it implies a separateness from the bulk of the chromosomal DNA which is entirely dependent upon the technique of isolation. However, in the continuing absence of a proven function of these special DNAs, the term satellite is at least short, functionally neutral and widely understood."

Properties of satellite DNA

There are several properties that one can attribute to satellite DNA. When the two strands of satellite DNA are separated, and then allowed to reassociate under proper conditions of temperature and ionic strength, it has been seen that they reassociate very fast. It has been recognised that renaturation of DNA obeys bimolecular kinetics. The rate of reaction depends upon the concentration of reactions, i.e., the specific sequence and its complements. The speed with which they reassociate is an indication of the fact that the base sequence of satellite DNA is repeated several times. There is a family of repetitive sequences.

Some sequences are repeated only a few times, others may be repeated several million times. This has given rise to the concept of genomic redundancy which says that genes or nucleotide sequences may exist from a unique sequence per haploid cell to a family of related sequences culminating in highly repetitive sequences.

Repetitive DNA is universal in Eukaryotes, some 30%-40% of the DNA may constitute repetitious types. These sequences may not be very long. For example, one type of mouse satellite DNA is 8-13 nucleotides long.

Obviously, the second qualification of satellite DNA is its different base composition, and consequently its buoyant density.

The G+C content of satellite DNA is different from the bulk DNA. It is this property which makes it easy to separate from the main band DNA. Satellite band in CsCl may be further separated from the main DNA by its binding with certain drugs.

Satellite DNA, having a special set of sequences, shows different affinity for cations. Caesium sulfate gradient in the presence of heavy metals such as Hg^{++} or Ag^{++} sometimes reveals several satellite bands, all of which constitute only one satellite band in CsCl.

Since there is a correlation between the base composition and the melting temperature (Tm) one would expect that the temperature at which satellite DNA melts by half (Tm) would also be different.

Satellite DNA has also shown an intrastrand bias. What this means is that the two strands of this DNA in the alkaline CsCl gradients form two distinct bands; one contains the L strand and the other the H strand. During DNA duplication of synchronised mouse cells, satellite DNA, containing A T rich sequences, replicates later than the sequences rich in G+C content. Satellite DNA also exhibits the property of self-strand association. It has been shown by W. G. Flamm of U.S.A. that the two light strands would reassociate when natural conditions were created. Similarly, the two heavy strands would reassociate to produce a duplex. Normally if the two strands of a double helix are separated and then allowed to reanneal, the Watson strand will register with the Crick strand, following the base-pairing rule. It is not expected that the two Watson strands or the two Crick strands would reassociate. Since the satellite DNA exhibits self-strand association, an explanation for this phenomenon can be given by assuming that this DNA contains sets of reversed sequences. These sequences occur at regular intervals along the satellite DNA molecule.

Localisation of satellite DNA

In the interphase of cell division, satellite DNA is located in the perinucleolar hetero-chromatin. Using the method of *in situ* hybridisation, Joseph Gall of Yale University (U.S.A.) has shown that mouse satellite DNA hybridises near the region of centromere in all chromosomes except Y chromosome. Giemsa Stain detects highly repetitive satellite DNA within the metaphase chromosome.

Function of satellite DNA

Satellite DNA is not transcribed *in vivo*. It does not serve as a template for RNA. It has nonsense codons.

Satellite DNA probably plays the organisational role. It may act as recognition sites and thereby help in the pairing of homologous chromosomes during meiosis. Satellite DNA may also play a structural role as it is located near the centromere.

These sequences may provide strength to the centromere and thus reduce the chances of non-disjunction.

It is often suggested that some satellite DNA may have a "house keeping function." It is possible that the satellite DNA localised at the distal end of the chromosome reacts in some manner with the centromeric satellite and thereby renders some inbetween genes inactive. This role may be played during differentiation.

Satellite DNA may protect the genome from disruptive forces. Satellite DNA may help in the folding of the chromosomes. This DNA probably acts as fertility barrier between the two closely related species.

Evolution of satellite DNA

Highly repetitive sequences probably evolved in response to an increase in the size and complexity of chromosomal and nuclear organisation of the cell. Repetitive sequences evolved by gene amplification. They are preserved by natural selection in order to protect other genes that could not sustain evolutionary changes.

The amount and base composition of satellite DNA vary considerably even among the closely related species with a common ancestry. It is indicative of the fact that the ancestral sequence is not at all preserved and each species develops its own sequence.

During the process of speciation the old sequences must be eliminated or lost. Highly repetitive sequences thus have a high rate of evolutionary turnover and they do not leave any trace of the past. These sequences are young and after the species formation have accumulated a large number of mutations. Since these sequences are not transcribed, it is possible that they are not stringently conserved during the course of evolution. Satellite sequences are not older than the species and they bear testimony to the mutagenic pressures the species has undergone.

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Melittin—an important allergen in bee venom

THE toxicity of bee venom is well-known, but its composition and mode of action have been worked out only recently. It contains a variety of small molecules such as free amino acids, sugars, lipids, amines and peptides. Enzymatically important compounds present in it are histamine, dopamine, noradrenaline, melittin, phospholipase A, apamin, minimine, mast cell-degranulating peptide, and hyaluronidase.

Melittin is the main component of bee venom. It constitutes about 40% of it by weight. One of the important allergens present in bee venom, it is isolated from the latter by chromatography on G-50 Sephadex. It is further purified from the eluate. Natural melittin contains 25 amino acids. Its molecular weight is 2850 and the polypeptide chain is arranged in random conformation. It contains 3 lysine and 2 arginine residues but no free carboxyl group. The primary structure of melittin is unique in that the N-terminal end contains mainly amino acids with hydrophobic side chains and the C-terminal end is mainly made of amino acids with hydrophilic side chains. Hence the molecule is a natural surfactant, and many of its toxic reactions can be attributed to this property. The peptide, however, lacks aspartic acid, tyrosine phenylalanine and sulphur-containing amino acids.

Melittin differs from phospholipase A, another important allergen in bee venom in that the latter acts only indirectly by formation of lysolecithin from lecithin. Melittin hemolyses RBC directly and does not require lecithin for action.

In toxic amounts melittin can cause death of an animal but the precise event leading to death is not known. Recent reports regarding elevation in blood serum levels of some enzymes suggest possible damage to liver, myocardium and kidneys. The basis of the above pathological effects could mainly be due to the toxicity of melittin and/or some other cytotoxins present in the bee venom.

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What are phytoalexins ?

IT is a well-known fact that many plant diseases are caused by fungi. The organism which causes the disease is called the pathogen and the plant is called the host. During the entry and establishment in the host plant, pathogens produce certain metabolites like enzymes, toxins, etc., which are harmful to the host. In response to the harmful activities of the pathogen, the host plant produces some compounds which are mostly phenolics. They are called phytoalexins. Phytoalexins are defined as fungitoxic substances which are produced as a result of the interaction of two metabolic systems, host, and parasite and which inhibit the growth of the pathogens.

Some of the phytoalexins reported are :

Ipomeamarone. It is produced in sweet potatoes infected by *Ceratocystis fimbriata.* More ipomeamarone is produced in resistant varieties than in susceptible ones following infection. It is non-phenolic furanoterpenoid and appears to be synthesised via the acetate pathway.

Orchinol. It is produced by *Orchis militaris* upon infection by *Rhizoctonia repens.*

Isocoumarin. It is produced at the site of penetration of carrot roots by *Ceratocystis fimbriata,* a non-pathogen of carrot roots.

Pisatin. Produced in endocarp of detached peapods in response to the infection by *Aschochyta pisi.* Its production can be reduced by high temperature of anaerobic storage.

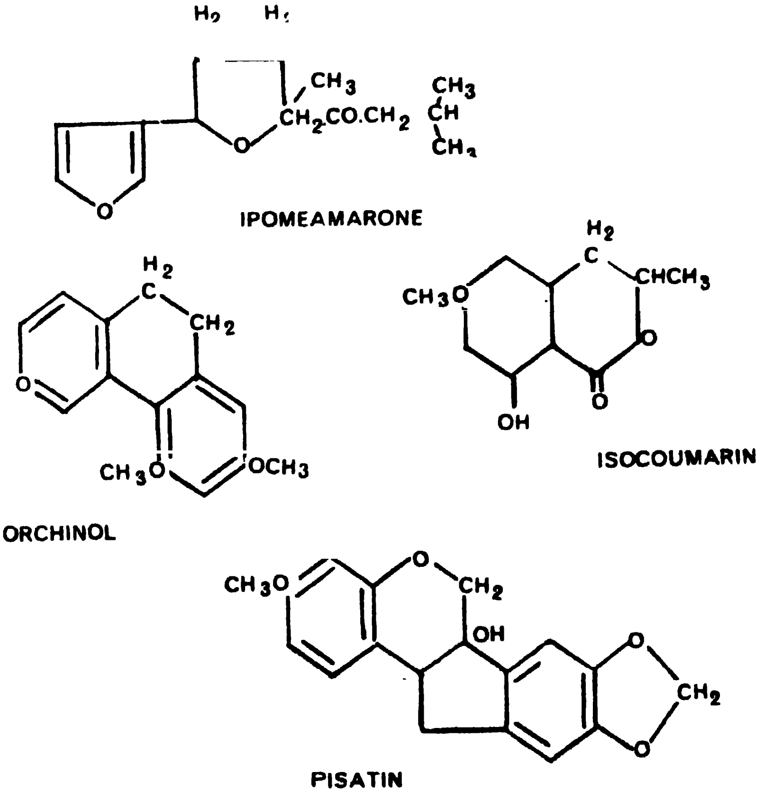

Fig. 1

Phaseolin. It is similar to pisatin in chemistry and function. It was isolated from detached, opened bean pods following inoculation with the non-pathogen *Monilia fructicola.*

Excepting ipomeamarone all others are synthesised via the skikimic acid pathway. The structures of the above phytoalexins are given in Fig. 1.

The defence reaction is confined to the tissue colonized by the pathogen and the speed with which they are produced depends upon the degree of resistance of the host. The sensitivity or capacity of the host to produce phytoalexins is governed by genetic factors and a gene-for-gene relationships in host parasite reactions appears to be present.

The isolation, characterization, mode of action, and biosynthesis of phytoalexins in a larger group of plants than considered here present a major challenge, and are an exciting fields in plant pathology.

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What is an insect bite ?

WE all have experienced insect bite. Sometimes, however, severe reactions, either immediately or afterwards, due to allergy against the insect venom, may demand urgent medication. In some people allergic reactions may result from the bites and stings of insects such as bees, wasps, hornets, fleas, etc. In normal, non-allergic persons the injected substance acts as an irritant.

Many of these insects belong to the order hymenoptera. These social insects build nests or hives above or under the ground and have two pairs of membranous wings. The thorax and abdomen are distinctly separated through a slender connection. All workers and queens have a sting attached to the end of the abdomen; the sting is connected by a short duct to the venom gland. In most hymenoptera, including the wasps, the sting is smooth, resembles a hypodermic needle, and is withdrawn after stinging. But in the honey bee the sting has a barbed tip which makes its withdrawal impossible. Yellow jacket (*Vespa pencilvanica*), because of its aggressiveness and lack of fear from man, is dangerous and annoying to those who enjoy an out-door life.

Composition of venom

Most insect venoms contain histamine, serotonin and kinins. Wasp venom contains histamine, phospholipase A and B, serotonin, hyaluronidase and wasp kinin, whereas the venom of bee contains hyaluronidase and polypeptides melittin, apamin, mastocytitolytic peptide (MCL) and histamine. Fire ant (Myrmecophili) venom contains histamine, phospholypases and hyaluronidase.

Mode of action

Histamine in venom enhances the toxic effects of other components by causing hypotension, increased vascular permeability and formation of wheal and itching. Histamine, serotonin, kinins and acetylcholin, produce pain. The kinins cause local vasodilation (dilation of blood vessels increasing their diameter), increased capillary permeability, diapedesis (leaping through blood vessels) of leukocytes and pain.

Normal reaction

At the time the sting is inserted, there is a sharp pricking sensation followed by a general pain. Within a few minutes, a small reddish spot appears at the sting site and it is gradually surrounded by a whitish zone and a reddish flare. A wheal then forms and it subsides in a few hours producing irritation, itching and heat. Normally, insect stings are not much dangerous. However, if the sting is around the eyes, nose, or throat, the local reaction may cause more pain than common distress. The local reaction begins immediately or after an interval of time and may last for one day or several days.

Toxic reactions

They may develop when the amount of the venom injected is large. The principal symptoms are gastro-intestinal disorders with diarrhoea and vomiting, fainting and unconsciousness. These symptoms are accompanied by oedema without urticaria, headache, fever, drowsiness, involuntary muscle spasms and sometimes convulsions.

Therapy

For an ordinary, uncomplicated insect bite, calamine lotion with or without 2 per cent phenol should be adequate. For any kind of insect bite, antihistaminic tablets taken orally is proves helpful. For swelling, antihistaminic ointments can also be used. The stings of ants, bees and wasp are treated differently, because bee venom contains formic acid. The venoms of wasp and ant are alkaline. The bee also leaves its sting and venom sac behind. So care must be taken to remove the sting and venom sac gently with the help of forceps or finger nail. The sac should not be squeezed or else more venom would be injected. After removal of the sting, the appropriate local antidote like weak ammonia, bicarbonate of soda or washing blue should be applied but not rubbed. The wasp venom contains hyaluronidase and two per cent histamine which is neutral or alkaline. The local antidote for ant, wasp and hornet stings is vinegar or lemon juice. As the wasp is a scavenger, secondary infection is more likely to occur and an oral antibiotic may become necessary.

Anaphylactic reaction which is a severe manifestation of allergy to foreign protein, may, however, complicate the situation after the sting of a bee, wasp or hornet. In these conditions, adrenaline given subcutaneously or intramuscularly every ten minutes can elicit a response. Systemic steroids such as hydrocortisone are also used in severe cases of vasomotor collapse, a condition in which there is profound dilation of blood vessels and decrease in blood pressure.

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Do snakes appreciate music ?

THE organ of hearing in mammals and man is a complex structure and the mechanism of hearing is quite complicated. In most mammals, the hearing apparatus consists of a sound-collecting external ear, the pinna, which leads to a tubular external auditory canal (Fig. 1). At the end of this canal lies the ear drum (tympanic membrane or tympanum). The next portion of the hearing apparatus is the sound transmitting middle ear which consists of three auditory ossicles (malleus, incus and stapes). In the inner ear occurs the membranous labyrinth consisting of three semicircular canals and a spiral cochlea. The eustachian tube, an air filled cavity, connects the middle ear with the pharynx and equalizes pressure on both sides of the ear drum. Sound waves collected by the pinna pass through the ear drum and produce vibrations in the cochlea. Nerve impulses are initiated in the organ of Corti of the cochlea and then transmitted by the auditory nerve to the brain.

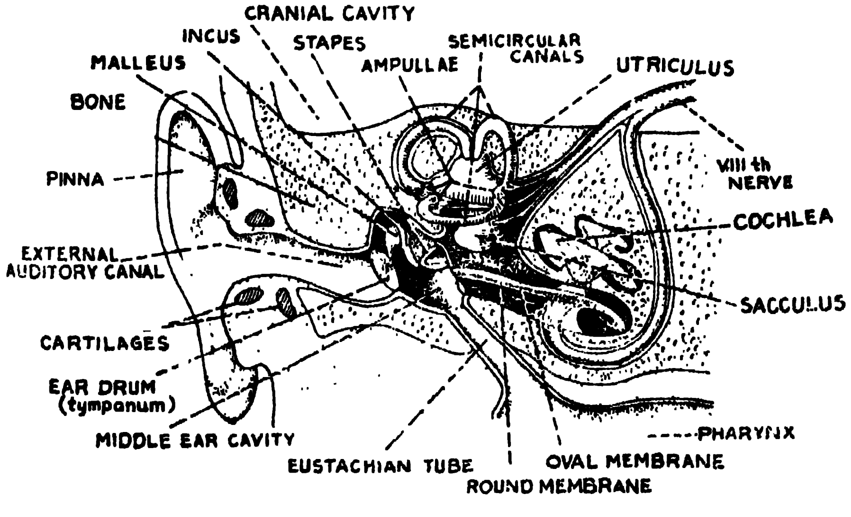

Fig. 1. General structure of the ear of man

Snakes do not have auditory structures such as the pinna, ear drum, tympanic cavity, or the eustachian tube. Their auditory apparatus consists of a bony or semi-cartilaginous rod, the columella auris, which corresponds to the stapes in mammals (Fig. 2). This bone extends from the fenestra ovalis in the cranium to the quadrate bone.

Because of the rudimentary nature of the ear apparatus, it is believed that snakes cannot hear air-borne sounds. They are however very sensitive to ground vibrations which are transmitted to the columella auris through the bones of the lower jaw. That is how a snake may detect the approaching foot-fall.

P. J. Deoras, a noted ophidiologist of the Haffkine Institute, Bombay, conducted a number of experiments with different snakes with regard to their reaction to air-borne and earth-borne sounds and music. In his experiments with a cobra inside a tin box, he noticed that playing of fine soft tunes of music near the tin had no effect on the snake. On the other hand, "any blaring sound that impinged heavily on the tin made the cobra raise its hood". Deoras states, "One snake charmer was taken inside our snake farm and made to play his routine gourd music which is supposed to attract snakes. There was no response and no snake came out. It was only when he blared the gourd music on the dealwood substratum, the cobra

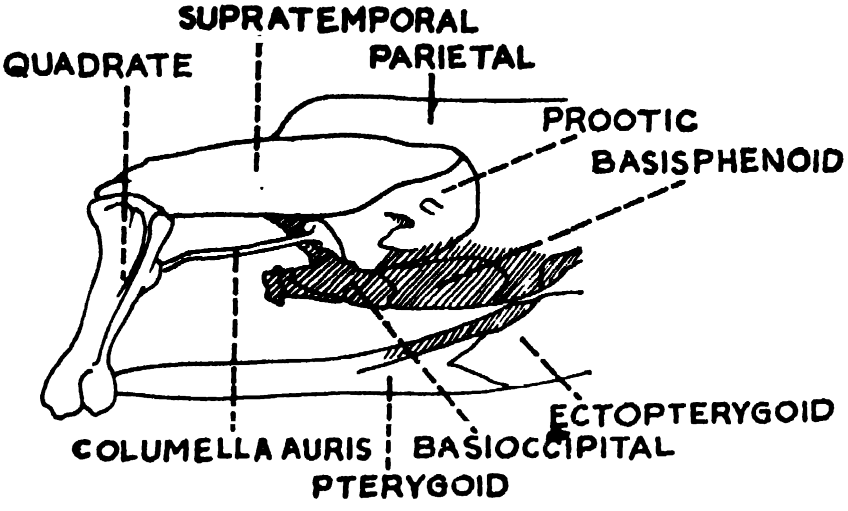

Fig. 2. Ear bones of python (seen from right side)

inside raised its hood. Similarly, merely playing gourd music did not make the cobra sway its hood. It was when the charmer shook his flute and hand that the cobra swayed with the specific purpose of getting an aim to attack and it did try to strike once or twice." The snake has no eyelids and therefore they are open all the time. Legends have been built up that snakes hear through the eyes, and hence the name *chakshushraba* meaning the animal that hears with its eyes.

Recently, results of some experiments carried on the response of some snakes to music have been published in the *Journal of Bombay Natural History Society* (Vol. 73, No. 1, April, 1976). A team of five experts, consisting of two otorhinolaryngologists, two zoologists and a research fellow, used the common rat snake or dhaman (*Ptyas mucosus*), the banded racer (*Argyrogena fasciolatus*), the Ceylon cat snake (*Bioga ceylonensis*), the John's sand boa (*Eryx johni*) and the green whip snake (*Ahaetulla nasutus*). Of these, the Ceylon cat snake and the green whip snake are known to be mildly poisonous.

The results of the experiments are quite interesting. None of the five species of snake responded to pure tones irrespective of the frequency or intensity in the plastic annular activity chamber in which the experimental snake was placed. However, the snakes responded to music, both instrumental and drum, fed to the activity chamber through an audiometer at 50 and 100 decibel intensities. While the rat snake, the banded racer and the Ceylon cat snake exhibited very good response to musical sound, the other two showed no specific response. The sand boa was highly inactive and indifferent while the green whip snake, though active, did not respond to music appreciably. It is interesting to note that the response of the three snakes to music was chiefly one of fright.

The experiments prove that snakes have a limited hearing capacity but some of them do react to music of low intensity and that the reaction is chiefly of fright.

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"But my neighbours tell me that since my wife started singing, this once snake-infested neighbourhood is now free of snakes."

Egg-laying mammals

THE mammals represent a highly evolved group of animals. The young ones need nourishment from the mother for a certain period before they can lead an independent life. Exceptions, how-

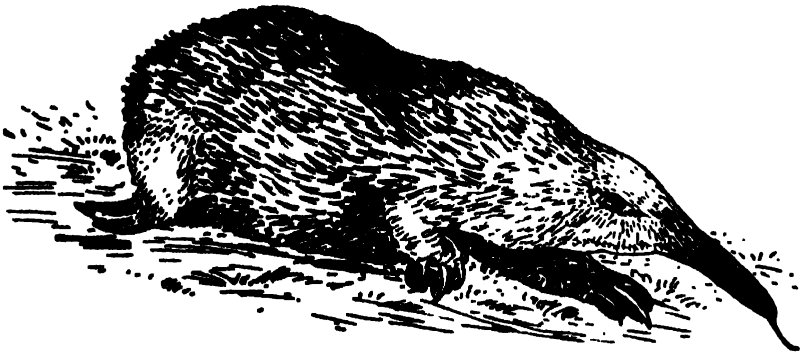

Fig. 1. Porcupine anteater

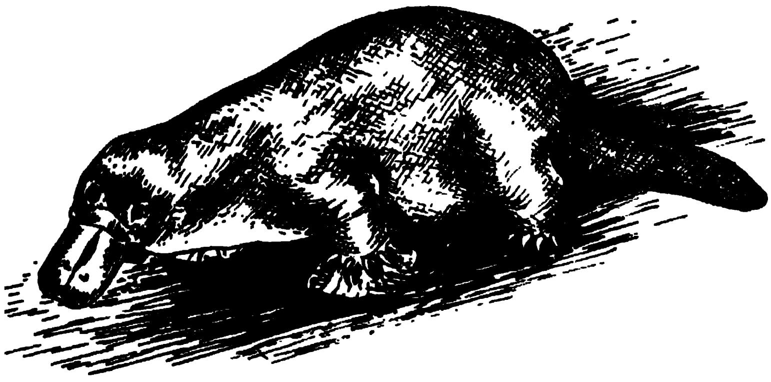

Fig. 2. Duck-billed platypus

ever, occur in nature. There is a group of animals which possesses some of the essential characteristics of mammals but is egg-laying in habit. Such animals are known as egg-laying mammals of monotremes and are included in the order Monotremata of the sub-class Prototheria under the class Mammalia. The order is represented by two living forms viz., *Echidna* or spiny anteater and *Ornithorhynchus* or duck-billed platypus. Unlike all other existing mammals, besides laying eggs, their left and right oviducts remain separate and do not unite to form a median uterus. The ducts leading from ovaries and testes open into a single cloaca or a common outlet.

The spiny anteater

The spiny anteater, commonly known as porcupine anteater, is about 76 cm in length (Fig. 1). Its body is covered by long pointed spines. In size and appearance it resembles a hedgehog. It has a long, tapering beak and a rudimentary tail. The teeth are absent in all stages of development. The posterior of the tongue has horny structures which grind the food against corresponding ridges on the palate. The tongue is long, extensile and lubricated with a viscous secretion which helps in ant eating. It feeds on insects and worms. The claws are generally three in number—strong, powerful and used for digging the burrow. It is mainly nocturnal and prefers densest scrubs of the bush or rocky spots where it is free from intrusion.

The temperature of the body of *Echidna* is less than that of the higher mammals, i.e., 25°C -28°C (37°C in higher mammals). It is thus an intermediate between the cold-blooded (poikilothermal) and warm-blooded (homoeothermal) animals. Some authors are of the opinion that *Echidna* hibernates during winter months.

The egg-laying habit and the parental care of *Echidna* is very interesting. Oviposition in these animals has not yet been observed. However, the female is able to curve her body sufficiently to lay the single egg directly into the ventral pouch (incubatorium) which develops during the breeding season. In case the egg has been laid on the earth it could also be transferred into the pouch, by the female *Echidna* with the help of her strange beak-like mouth. The egg is hatched inside the pouch and the shell is removed by the mother with her mouth. When the young has attained a certain size, the mother removes it from the pouch but takes it in from time to time to suckle it. The pouch inside contains the mammary glands which are without nipples. The young licks milk from the portion of the skin where mammary glands open. Sucking continues until the spines of young one become troublesome to the mother. This habit of carrying the egg and feeding the young in the pouch, together with the remarkable protection afforded by spines and special burrowing habit, has been a principal factor in the animal's survival. At night, when the female goes out for food, she always puts the young one out of her pouch and gets forth alone.

When attacked by enemies, it seeks to escape either by rolling itself into a ball or by burrowing rapidly into the sand.

The duck-billed platypus

The duck-billed platypus (Fig. 2) is popularly known as duckmole. It is semi-aquatic in habit and measures about 61 cm in length, of which the tail is 15 cm long. It is dark brown on the upper part and whitish below. The body is covered with dense fur. The limbs are short and five-toed. The anterior toes are webbed. The beak is broad, flat and is covered with a soft, sensitive skin which is tactile in nature. Teeth persist at the young stage and are shed like the milk teeth of human beings. They are all molars and are replaced by the horny plates in the adults.

The burrowing habit of platypus has drawn the attention of naturalists. It excavates a burrow for itself on the banks of slow streams. The burrow has one opening below and one above the water and measures about 6-15 meters in length. When it finds an aquatic intruder it runs through the opening on the land. When a land intruder enters into the burrow it escapes through the opening below the water.

The platypus feeds on worms, snails and muscles. In common with other mammals, it has check pouches for the temporary storage of food. It is energetic and restless. And like all small mammals of this disposition, it consumes its own weight of food each day.

Courtship and copulations are performed in water. The female prepares the nest in which eggs are laid. The ovum is about 0.254 cm in diameter at the time of fertilization. After fertilization it becomes surrounded by a thin layer of albumen outside of which is a thin, transparent, horny shell. It grows to a size of 1.5cm-1.8 cm before oviposition. The platypus lays two eggs at a time which resemble those of lizards. How are the eggs laid? The female sits curled-up and receives them in her fore-paws. They are then placed between the curled-in tail and the abdomen where they are brooded. The platypus snuggles them to her warm body and hatches them like a bird or a snake. Freshly hatched young ones are very small, blind and naked. They possess a very short bill with lips.

For sometime after the youngs are hatched, no milk is secreted. There are no nipples and the young licks the milk directly from the surface of the mammary field.

The platypus is one of the most timid beasts and difficult to approach. Unlike *Echidna*, it does not thrive in captivity.

Distribution

The egg-laying mammals are exclusively confined to Australia, New Guinea and New Zealand. It is presumed that Australia and its nearby islands were once upon a time connected with other continents like Asia, Africa and South America, etc., and all these continents were also united with Antarctica to form a huge continent, the Gondwanaland. The Gondwanaland had broken up into modern continents which have drifted to their present positions. The geological changes of the past have also affected the geographical distribution of animals. When the modern continents drifted to their present positions, the original land bridges vanished and the animals living in the then large continent were thus isolated.

The reptiles, from which these mammals have originated, are egg-laying in habit. It is believed that the monotremes have evolved towards the mammalian line by developing certain mammalian characters but retain the egg-laying habit of the reptiles in addition to other anatomical reptilian features. Hence, this group of animals serves as an intermediate form between reptiles and mammals and as such are known as primitive mammals.

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NEWS AND NOTES

(Continued from page 457)

Institute, Lucknow, outlined his work on different types of chemicals of industrial significance which could be produced from molasses and cellulosic wastes. Dr. H. N. Astana, CFTRI, Mysore, underscored the need for developing bioengineering as an important academic discipline in India to meet the future growth of fermentation industry.

Symposium ended on a note of optimism on the future of industrial microbiology in India and its role in solving some of the more pressing problems facing the country particularly in the area of energy and recycling of waste. This was highlighted in his guest lecture by Dr. K. S. Gopalkrishnan, Chief Mycologist of Hindustan Antibiotics Limited. He wondered whether technological skills would be adequately available to meet the future growth of this industry mainly through trained graduates from the universities.

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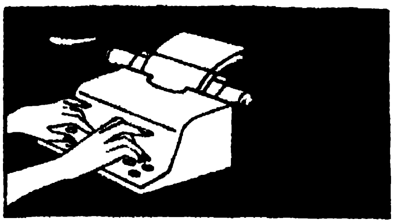

NEWS & NOTES

Satellites discovered around planet Uranus

DR. J. L. Elliot of Cornell University and Dr. Robert Millis of Lowell Observatory in Arizona (U. S. A.) announced on March 11, 1977 that they had discovered a swarm of satellites around the planet Uranus. Uranus was previously thought to have only five satellites. Dr. Elliot said that the swarm could contain upto 100 satellites. This would mean that Uranus, 1.8 million miles from earth, has more satellites than any other planet. Dr. Elliot made this observation from the United States National Aeronautics and Space Administration's (NASA) C-141 flying observatory over the Indian Ocean. Dr. Millis spotted the same swarm using the Perth Observatory's reflecting telescope at Bickley. Dr. Elliot came to Perth to watch Uranus pass in front of a relatively bright star using a NASA telescope from the plane. He said he had identified several satellites with diameters of from 18 to 24 miles. Dr. Millis said he had identified a satellite about 60 miles in diameter. Both said the swarm of satellites would have been visible only within 30 miles north and south of Perth, or perhaps from a South African observatory. It would take two to three months to analyse the information collected on the size and atmosphere of Uranus. Both astronomers believed that this discovery was of major importance for the revival of the Mariner space probe to Jupiter and Uranus.

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Symposium on industrial microbiology

LEADING scientists from all over India participated in a two day symposium on perspectives in Industrial Microbiology on 2nd and 3rd April 1977 at Bombay to discuss recent developments in fermentation technology and their relevance to future of fermentation industry in India. The symposium, inaugurated by Shri P. N. Haksar, Deputy Chairman of Planning Commission, was jointly convened by Hindustan Lever Research Centre (HLRC) and Association of Microbiologists of India (Bombay Unit) at HLRC in Andheri, Bombay. The symposium was divided into four areas of interest to the fermentation industry : (1) Fermentation as a low cost technology, (2) Immobilisation as a technique for fermentation, (3) Application of genetics to industrial fermentations, and (4) Production of chemicals through fermentation. Prof. J.V. Bhat (Kasturba Medical College, Manipal) in his paper on the rural and urban waste recycling said "there is no material in the world which can be called waste." By employing the resources of chemical and biochemical processing, it is possible to carry out biological reorientations of any type of molecule available in nature and to convert it into a more useful product. Dr. V. Jagannathan of National Chemical Laboratory, Pune, and Dr. B.K. Gupta, of Gobar Gas Research Institute, U.P., outlined their studies on utilisation of cellulosic wastes for production of glucose and single cell proteins and the production of methane respectively. Techniques for immobilisation of whole cell, multi-enzyme systems and single enzymes to the solid supports such as silica, dextrines, semi-permeable membranes, etc., to carry out complex and specific reactions have received considerable prominence in recent years. Dr. S. Ramchandran, Hindustan Antibiotics Ltd., discussed recent developments in immobilising whole cells and multi-enzyme systems on solid supports and their applications to the industry. Dr. Bimal Bacchawat, Indian Institute of Experimental Medicine, Calcutta discussed his studies on affinity characteristics of artificial cells and their medical application particularly in delivering specific enzymes and possibly drugs to the target organs. Eventual application of this approach to medicine will revolutionise the concept of drug therapy. Prof. P. K. Bhattacharya, Indian Institute of Science Bangalore, gave a highly interesting and speculative talk on possible application of immobilised enzyme system to carry out specific chemical transformations.

The final session of the symposium discussed the feasibility of producing chemicals by fermentation of agricultural wastes. Dr. V. Srinivasan of Sarabhai Research Centre, in his keynote address discussed economic feasibility and future of processes for the synthesis of chemicals through fermentation based on agrochemical wastes. Dr. A. W. Khan, Central Drug Research

(*Continued on page* 456)

MEDICAL NOTES

Gall-stones—how do they form and dissolve in the body?

GALL-STONES or gall bladder stones are the concretions in the gall bladder or a bile duct composed chiefly of cholesterol crystals, bile pigments, lime salts, and small amounts of other organic material. Based on their chemical composition, gall-stones are classified into four types : (i) Cholesterol stones; (ii) Mixed or laminated stones; (iii) Bile-pigment stones; and (iv) Calcium carbonate stones. The gall-stones are of frequent occurrence in humans giving rise to serious and painful effects though remaining unsuspected and undetected in the early part of life. The "silent gall-stones" are detected either by X-ray at operation or during post mortem. Otherwise they are felt and discovered only in the late adult life, especially in those of obese structure. Interestingly, gall-stones are much commoner in women than in men; further they occur much more frequently in women who have children than in nulliparae.

There are several factors that lead to gall-stone formation in the body. Of all these, the dietary factors are most important. People habitual of taking excessive fats (especially saturated or hydrogenated oils) are the biggest sufferers of gall-stone malady. Saturated oils also lead to atherosclerosis causing heart attacks. J. J. Norton and his associates demonstrated in 1968 that gall-stones and gall-bladder diseases were due to a metabolic defect involving lipid and cholesterol metabolism. The increased incidence of diabetes in gall-stone patients is considered to be another expression of this fact (*Amer. J. Gastroenterol.*, **50**, 214-220, 1968). Two other chief conditions which are also generally recognised as factors causing gall-stone information are : (a) stasis of stagnation of the bile, and (b) bacterial invasion leading to catarrh. The former condition is produced by an atonic state of the gall-bladder occurring in association with constipation, which is common in stout women and is favoured by conditions thrusting pressure on the gall-bladder. The composition of the bile in individuals also plays an important role in the stone formation.

D. J. Sutor and S. E. Wooley in 1971 carried out X-ray powder analysis of the gall-stones removed from patients from 8 different countries—Australia, England, Germany, India, Kuwait, South Africa, Sweden, and United States—showing the presence of at least 11 other chemical constituents besides cholesterol (*Gut*, **12**, 55-64, 1971).

Now, a startling discovery on the gall-stone formation tendency of a popular steroidal drug prednisolone has come to light recently. A group of six doctors headed by S. Schubert at Karl Marx University, Leipzig (E. Germany), accidentally discovered the formation of gall-stones in guinea pigs by prednisolone administration (*Z. Exp. Chir. Forsch.*, **8**, 41, 1975). Chemical analysis of the stones thus formed revealed the presence of cholesterol, biliverdin, and calcium, The formation of gall-stones under prednisolone administration was effectively prevented by the simultaneous administration of high doses of vitamin C. However, stones already formed did not regress with the administration of vitamin C or other drugs. In current therapy prednisolone occupies a specific and selective position in the treatment of rheumatoid arthritis and allied conditions. It is also prescribed in bronchial asthma, various inflammatory eye diseases, dermatoses, and allergic disorders. The side effects of prednisolone, right from the publication of first paper on its use by J. J. Bunim *et al.* in 1955, have been considered to be mild and negligible (*J. Amer. Med. Assoc.*, **15** , 311, 1955). But, in the wake of new findings in East Germany every precaution should be taken while taking or prescribing prednisolone. In fact, the latter must not be taken without appropriate doses of vitamin C so as to prevent the formation of gall-stones.

A latest theory (1973) on the formation of gall-stones from bile has been put forward by T. Maki and N. Suzuki of School of Medicine, Tohoku University, Sendai (Japan) (*Tohoku J. Exptl. Med.*, **84**, 259, 1973). Their theory is based on a series of *in vitro* experiments which produced gall-stone-like concrements from a suspension of human bile sediment consisting mainly of calcium bilirubinate. The theory proposes that gall-stone ingredients separated from bile first form stable lyophobic colloids. These colloids soon decrease in stability from the effects of inorganic electrolytes and high molecular weight organic substances of bile. The colloids are then deposited as flocs which solidify into stones.

The gall-stone formation causes irreparable damage to gall-bladder and liver, and is still believed to be an incurable malady. Hitherto, there was no suitable medicine

(*Continued on page 472*)

FOR HER

Bath powders

BATH powders (1) make the user feel refreshed, (2) add pleasing effect to the bath by means of perfume and colour, and (3) clean the body by removing dirt and odour and add a pleasing fragrance to the body.

In the past they consisted of corn and rice, starch and boric acid, but modern bath powders are generally made of talc as the major ingredient (60% to 90%). Chemically talc is a mineral [Magnesium tetra silicate ($Mg_3Si_4O_{10}(OH)_2$ or 3 MgO_4 SiO_2 H_2O) usually with whitish, greenish or grey colour]. It is the softest material available and is responsible for the feel of the powder. Many other ingredients in smaller amounts are used to give desired effects to the finished product. They are chalk, zinc oxide, magnesium carbonate, kaolin, titanium dioxide, and zinc stearate.

Special perfumes are used in bath powders to cover up the undesirable odour of the ingredients. About 5% magnesium carbonate ($MgCO_3$) is used to absorb the perfume and hold it in the finished product. The perfume oil is mixed with magnesium carbonate before being added to the rest of the ingredients.

A small amount of titanium dioxide (TiO_2) (1% to 2%) is added to give some opacity to the talc if desired. Zinc oxide and chalk can be added to impart greater bulking density and to assist in packaging by giving a good fill in the container. Kaolin helps the powder cling to the body while zinc stearate gives the desired slip.

Table 1

	1	2	3	4
Talc	80%	70%	90%	60%
$MgCO_3$	5	5	4	5
Kaolin	5	7	—	—
TiO_2	2	—	—	2
Zinc Stearate	7	4	5	10
ZnO	—	3	—	12
Chalk heavy	—	10	—	10
Perfume	1	1	1	1
Colour	qs	qs	qs	qs

If colour is desired in the bath powder, the earth oxide (with little taste or smell) colours should be used. Cosmetic grade iron oxide will give a light, pink colour and ochre (a sort of earth used for making pigments) a light tan one. A mixture of these two will produce a flesh tint. This type of colour should be added as an extender to the other ingredients after they are uniformly blended. The extender should consist of uniformly mixed dry colour (25%) and talc (75%).

Several formulae are given in Table 1.

Procedure

Mix all the ingredients except magnesium carbonate. If a perfume fixative is to be added to counteract the earth odour, it is to be added at this point in the form of 1% alcoholic solution. Mix them well. Mix magnesium carbonate and perfume in a separate container and add. If a colour is desired, it is added in the end.

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Probable hazards of baby formula

BABIES fed with commercial preparations rather than mothers' milk may be undernourished, according to a study presented at an experimental biology meeting in McCormick Place, Chicago. Most commercial baby formulae lack taurine, a common amino acid required by the body for digestion, to prevent degeneration of the eyes' retina, and possibly for brain development, the researchers said. "There is a good posibility that we should revise our thinking about what they put into these tin cans (for instant formulae)" said David K. Rassin, who presented his findings at the Federation proceedings. It could as well be that we need to reformulate that these are just bad formulae. While human milk is rich in taurine, cow milk is not. Cows milk is the basic ingredient for most commercial formulae.

In experiments with cats and kittens, animals fed a taurine-deficient

(*Continued on page 470*)

SCIENCE FOR THE YOUNG

X-rays: Discovery and applications

IN the last decade of 19th century, much work was done on the discharge of electricity through gases. X-rays, which are now so common and well-known, were discovered accidentally during such studies.

Consider a simple experiment with a gas discharge tube as shown in Fig. 1. The glass tube, about 30 cm long, contains air or some other suitable gas such as neon, helium, etc. It is connected to a gas pump through which gas can be slowly removed from the tube. There is also a pressure gauge to measure the pressure of the gas inside the tube. There are two electrodes A (anode) and C (cathode) at the two ends of the tube which are connected to platinum wires. A high voltage of about 10,000 volts or more is applied to the electrodes such that A is positive and C negative. When the pressure of the gas is reduced to about one-eighth of the atmospheric pressure, an electric discharge takes place causing the tube to glow. The atoms or molecules of the gas are separated into electrons and ions; electrons moving towards A and ions towards C. This is the simplest and earliest form of a cathode ray tube.

Discovery of X-rays

In 1895, a German physicist Wilhelm K. Röntgen was doing some experiments with a low pressure gas discharge tube. The tube was similar to the one shown in Fig. 1 with some differences. The pressure of the gas was very low—only about 10^{-9} of the atmospheric pressure (about 10^{-6} mm of mercury). The cathode was electronically heated so as to emit electrons by thermionic emission and a large potential difference of about 100,000 volts was applied between the anode and the cathode. The electrons emitted by the cathode were thus accelerated and so struck the anode with high velocities.

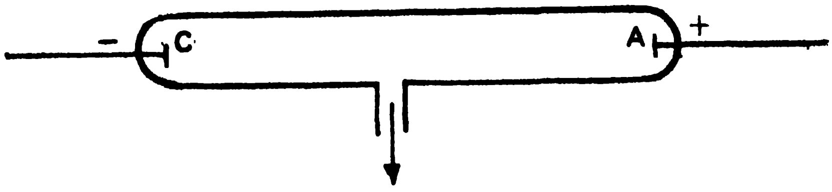

Fig. 1

Röntgen was performing this experiment for studying cathode rays, that is, the electrons emitted by the cathode. In the same laboratory, he had kept some photographic plates, carefully wrapped up in thick black paper, for some other purpose. On 8th November, 1895, Röntgen noticed that some mineral crystals, which were lying on his desk, suddenly lit up and began to fluoresce inspite of the fact that their distance from the tube was greater than the range of cathode rays. He also found, to his surprise, that the photographic plates were spoiled just as they would be if they were exposed to light.

It is a well-known fact that ordinary (visible) light cannot be transmitted through black paper or cloth. If we hold a black paper in front of our eyes, we are unable to see objects on its other side. But the surprising thing about Röntgen's photographic plates was that they were spoiled and fogged even when carefully wrapped in thick black paper. In a similar situation many of us would have perhaps thrown away the spoiled plates and would have abused the shopkeeper for supplying a bad lot of photographic plates. In fact, some previous workers had also noticed the fluorescence of minerals and fogging of plates near the discharge tube. Without giving it much thought, they only took care to keep the photographic plates away from the discharge tube. But not Röntgen! He immediately started investigating the cause of this mystery.

He noticed that only those plates kept in the same room as the discharge tube got spoiled; plates kept in other rooms of the laboratory did not. Thinking that the discharge tube was the cause of the mystery, he put off the discharge tube and brought some new photographic films in the room. He found that the new films did not get spoiled as long as the discharge tube was not in operation; they started getting fogged as soon as the tube was put into operation. He therefore concluded that there must be some radiation coming from the cathode ray tube which was falling on the photographic plates and spoiling them. This radiation must be very energetic so as to penetrate black paper and reach the plates. Röntgen could not say whether this radiation consisted of particles (like electrons, protons, etc.) or waves (as in sound or in rays of light). He therefore called it the X-rays (that is, the "unknown rays").

The story of Röntgen's discovery of X-rays is an important lesson for every scientist and, in fact, for every person. Whenever we find something unusual, we must not discard it as a mere accident, but must try to investigate its cause.

Soon, Röntgen performed many experiments to investigate the nature of X-rays. In doing so, he had to 'spoil' a large number of photographic plates—but that itself was his new experiment. He put in various objects, such as wood, glass, rubber, etc., between the discharge tube and the photographic plates. He found that the plates still got spoiled. He took aluminium sheets of different thicknesses and found that only an aluminium sheet of thickness 2 cm or more could stop the radiation and save the plates. As the rays could not be deflected by electric or magnetic fields, he concluded that they do not consist of charged particles. He also found that passage of X-rays through a gas increased its electrical conductivity. He attributed this to the separation of gas atoms into positive and negative ions, which contribute to the conductivity. In fact, this effect is still used as one of the methods to measure the intensity of X-rays. He also performed experiments with anodes of different materials to investigate the energy distribution of the X-rays.

In January 1896, Röntgen presented his researches before a meeting of the Physical and Medical Association of Wurzburg (Germany). His discovery was received with thunderous applause. Towards the end of the lecture, the skeleton photograph of the right hand of the German scientist von Kölliker, Honorary President of the Association, as depicted by the X-rays was shown. Von Kölliker suggested that X-rays be called "Röntgen rays" in honour of their discoverer, which brought unanimous cheers from the audience.

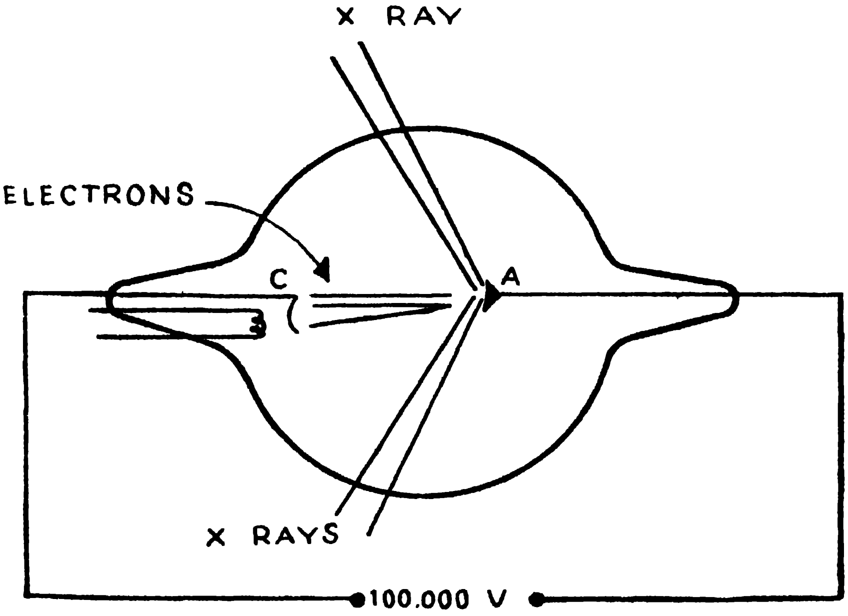

Fig. 2

Nobel prizes were initiated at the beginning of this century and, in 1901, Röntgen became the first person to receive the Nobel Prize for physics.

A conventional tube for producing X-rays is shown in Fig. 2. A high vacuum is created inside the tube so that the pressure is about 10^{-8} times the atmospheric pressure. The cathode is electrically heated as shown. Very high energy cathode rays (electrons) strike the anode at great velocities. The anode starts emitting X-rays. In this process, a large amount of heat is produced because the large amount of kinetic energy of electrons is converted into heat. They are suddenly stopped at the anode. As a result, the anode becomes hot and so it must be cooled. This is usually done by making the anode hollow and passing water through it (not shown in the figure).

It is now known that X-rays are electromagnetic waves similar to rays of visible light but have very small wavelengths and large frequencies and energies. The wavelength of an X-ray is of the order of $1\ A^\circ = 10^{-8}$ cm (about the size of an atom) while the wavelength of visible light lies between 4×10^{-5} cm and 8×10^{-5} cm. As the frequency is inversely proportional to the wavelength, the frequency of X-rays is about 10^3 or 10^4 times the frequency of visible light. Also, as the energy of an electromagnetic wave is proportional to its frequency, the energy of an X-ray is 1000 or 10,000 times that of a ray of visible light.

Continuous and characteristic spectra

It was shown in 1913 by a British physicist W. H. Bragg that X-rays from an X-ray tube consist of a continuous spectrum (also known as the "white" radiation) upon which are superimposed a number of bright lines which are characteristic of the material the anode is made of. This is because in an X-ray tube such as that shown in Fig. 2, X-rays are produced due to two reasons.

First, it is known from classical electrodynamics that an accelerated charge emits electromagnetic radiation. In the above experiment, electrons are undergoing a sudden acceleration (in fact, deceleration) when they are stopped by the anode. The electromagnetic radiation emitted due to this cause can have a continuous range of energies upto a certain maximum (or all wavelengths above a certain minimum) which depends on the velocity of the incident electrons. This radiation is known as the continuous radiation or white radiation as it consists of all wavelengths above a threshold.

Second, the high-energy incident electrons may knock out some of the inner electrons from the target atoms producing a vacancy in one of the inner shells of the atom. This state of affairs cannot remain for long. An electron from one of the outer orbits of the ion makes a transition to the vacant state in the inner orbit and the energy difference is emitted in the form of an X-ray photon. This is shown in Fig. 3, where a photon is denoted by the Greek letter γ (gamma). Because the energy levels of an atom are quantized, the emitted X-rays can only have one of a few discrete allowed energies which are characteristic of the atom and do not depend on the target as a whole or on the velocity of the incident electron. This radiation is known as the characteristic radiation. In fact, we can get substantial knowledge about the atom from a study of its characteristic X-radiation.

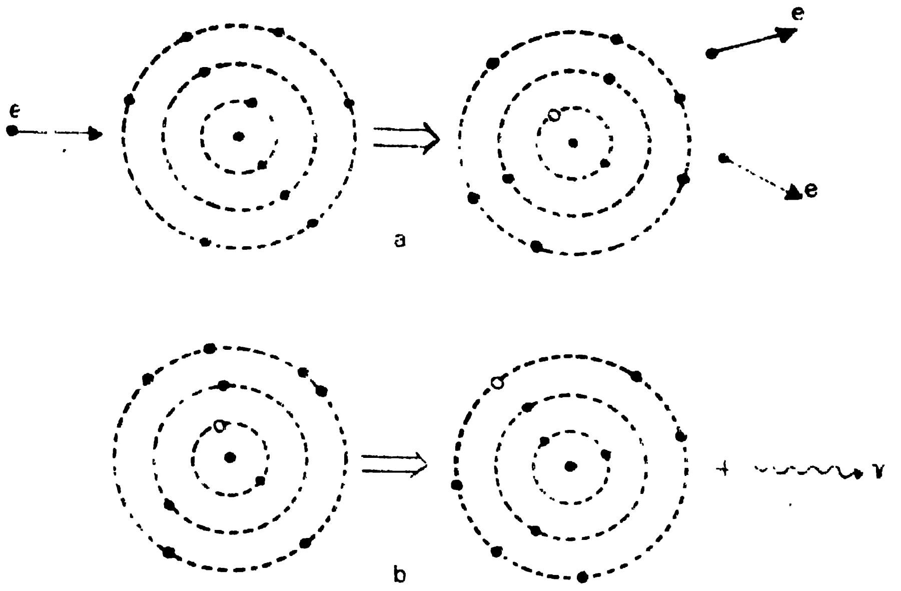

Fig 3

This also explains the fact that the energy of the characteristic X-ray, when a heavy element is used for the anode, is much larger than that when the anode is made of a lighter element. For example, in lead (atomic number 82), it requires 88.100 eV (1 eV$=1.602\times10^{-12}$ erg) of energy to knock out one of the innermost electrons. This corresponds to a wavelengths of 0.14 A°. In the case of aluminium (atomic number 13), it requires 1560 eV to remove the innermost electron, which corresponds to a wavelength of 7.95 A°.

The intensity versus wavelength spectrum of X-rays emitted from a typical X-ray tube is shown in Fig. 4. It clearly shows the characteristic X-ray lines superimposed on a continuous background of radiation. In this diagram, the area under the curve between any two wavelengths gives the intensity of X-rays between those wavelengths. So the area of the shaded portion in Fig. 4 is a measure of the intensity of X-rays having wavelengths between λ_1 and λ_2.

Uses and applications

More than 80 years have elapsed since the discovery of X-rays. In this period, a large number of experiments and investigations have been carried out on X-rays. At present, there is hardly any field where X-rays are not used. X-rays find applications in physics, chemistry, engineering, geology, metallurgy, biology, medicine, etc.

Medicine. It is found that X-rays can penetrate the flesh and blood to a greater extent than they can penetrate bones due to their calcium content. Therefore, if a beam of X-rays passes through the body of a person and falls on a photographic plate, the plate shows a shadow of the bones of the person. X-ray photographs of different parts of a person such as heart, lungs, stomach, kidneys, hands, legs, face, jaw, etc., can be taken. An irregularity or disease can thus be immediately detected. In case of a fracture, the exact location and nature of the bone crack can be detected and the bone can be set right properly. If a child gulps a pin or some other met-

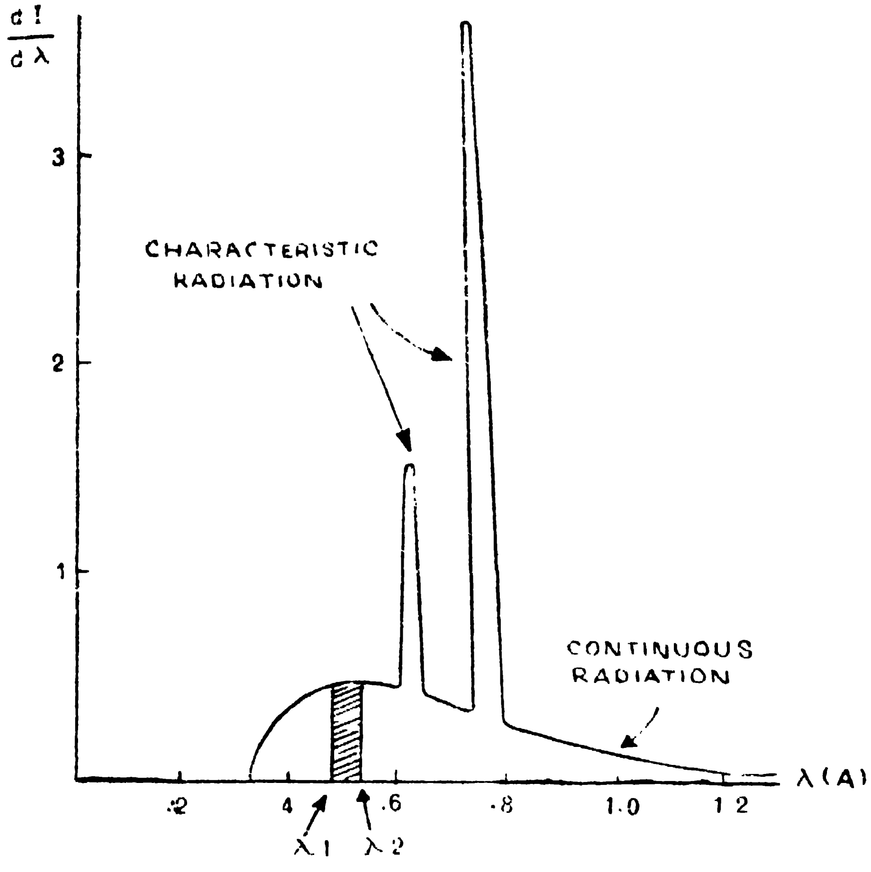

Fig. 4

allic object, an X-ray photograph can show in which part of the body the foreign material has been lodged. Tumours and cancer can be detected by X-rays. In fact, X-rays are also used in treatment of cancer; the process is known as radiation therapy.

X-rays induce chemical processes in tissues and organisms. It is found that they have a tendency to destroy diseased tissue more rapidly than healthy tissue, an aid in cancer treatment. Of course, any amount of X-radiation destroys some good tissue also, and a large dose can cause sickness and even death.

Physics and geology. X-rays are used to study the structure of crystals and minerals. By the structure of a crystal, we mean the exact arrangement of the different atoms inside the solid, the distances between various atoms, etc.

Chemistry and biology. X-rays are used to study the structure of molecules. The exact position and arrangement of atoms in large molecules can be determined by means of X-rays. It is by this means that structures of large organic molecules such as RNA and DNA, which are the building blocks of our cells, have been determined.

Metallurgy. Sometimes it is necessary to obtain metals without any cracks or defects. Even small cracks and defects can be detected by X-rays.

General. Recently, X-rays have found applications in detecting potential hijackers. At airports, every passenger has to pass through a special door fitted with an X-ray detecting apparatus (known as an X-ray eye). If a person has a pistol or a gun or any other metallic object, X-rays can detect it. The person is then searched for his belongings. X-rays are also used to detect fake paintings from genuine original paintings of famous artists. Because X-rays can penetrate most of the material except the lead contained in the paint, the X-ray photograph of a painting is quite different from what naked eye can see.

The use of X-rays in bone surgery is sometimes cited as an example of the importance and utility of basic research. In fact, within months of Röntgen's discovery, X-rays were used in January 1896 to set right a broken arm. Had Röntgen been busy with research on improvements in bone surgery rather than on cathode rays (which was a field with apparently no immediate applications), he could have probably never discovered X-rays.

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Magic squares

HAVE a look at Fig. 1. It consists of 169 consecutive integers from 68 to 236 arranged in 13 rows and 13 columns. Add up the numbers in any row or in any column or in any diagonal. In any case, the numbers add up to 1976—the last year! Such a square is called a magic square. This is a 13th order magic square. 1976 is called the magic constant of this particular 13th order magic square.

Definitions and formula

An *N*th order magic square is one in which N^2 distinct numbers are arranged in *N* rows and *N* columns such that the sum of the *N* numbers lying in any row or in any column or any diagonal is always the same.

A basic magic square (of any order) is one in which the starting % number is *1* and consecutive integers are used. The magic constant of a basic % magic square is called the basic magic constant. A knowledge of the basic magic constant is necessary to construct a similar magic square for any desired magic constant.

If *N* represents the order of the magic square, the basic magic constant is given by the formula $N(N^2 + 1)/2$. Table 1 gives the basic magic constants of various order magic squares.

Rules for construction of odd-order magic squares

The odd-order magic squares are very easy to construct if certain procedures or rules are followed.

Table 1

Order of the square	*Basic magic constant*
3	15
4	34
5	65
7	175
9	369
11	671
13	1105
15	1695

Rule 1. Fill in the middle square of the last column with the starting number. (In the case of the basic magic square, this number is 1.).

Rule 2. Move diagonally to the extreme right to the next appropriate row or column and fill in the squares with successive numbers.

Rule 3. If the move according to rule 2 takes you out of the confines of the figure (squares), fill in the extreme square of the next appropriate row or column with the next number and follow rule 2.

9 RULE 3	3 RULE 2			15 RULE 2
2 RULE 3 (R-2 is not possible)			14 RULE 2	8 RULE 2
		13 RULE 2	7 RULE 2	1 RULE 1
	12 RULE 2	6 RULE 4	5 RULE 2	
11 RULE 4	10 RULE 3	4 RULE 3		

Fig. 2

Rule 4. Rules 2 and 3 are followed till they carry you into a square that is already occupied. When this occurs, place the next number in the square immediately to the left of the square in which the previous number was filled.

Fig. 2 shows the application of the rules 1 to 4 for a 5th order magic square (basic). Numbers 1 to 15 are filled in accordance with the rules 1 to 4. If we want to fill in number 16, rules 2 to 4 take us beyond the confines of the figure. When this situation is reached rule 5 is to be followed.

Rule 5. If rules 2 to 4 take any number out of bounds, insert that number in the nearest available square and follow the rules 2 to 5.

Fig. 3 shows the completed square following the rules 1 to 5.

Magic squares with desired constants

Once we know how to construct a basic magic square, it is very

144	130	116	102	88	74	229	215	201	187	173	159	158
129	115	101	87	73	228	214	200	186	172	171	157	143
114	100	86	72	227	213	199	185	184	170	156	142	128
99	85	71	226	212	198	197	183	169	155	141	127	113
84	70	225	211	210	196	182	168	154	140	126	112	98
69	224	223	209	195	181	167	153	139	125	111	97	83
236	222	208	194	180	166	152	138	124	110	96	82	68
221	207	193	179	165	151	137	123	109	95	81	80	235
206	192	178	164	150	136	122	108	94	93	79	234	220
191	177	163	149	135	121	107	106	92	78	233	219	205
176	162	148	134	120	119	105	91	77	232	218	204	190
161	147	133	132	118	104	90	76	231	217	203	189	175
146	145	131	117	103	89	75	230	216	202	188	174	160

Fig. 1

9	3	22	16	15
2	21	20	14	8
25	19	13	7	1
18	12	6	5	24
11	10	4	23	17

Fig. 3

easy to construct a magic square to give any desired magic constant. The constructional rules are the same but the numbers used are different. The starting number is calculated in the following way:

Let us, for example, consider that we need a 13-order square with the magic constant 1976. The basic magic constant for a 13th order square is 1105 (Table 1). The difference between the required magic constant and the basic magic constant is 871. This difference divided by the order of the square (i.e., 13) is 67. The starting number is 67+1, i.e., 68.

Thus, if M_B is the basic magic constant and N is the order of the square, then the starting number is $M_D - M_B/N + 1$. We can, therefore, construct any odd order magic square to give any desired magic constant. The numbers used will be integers (+ve or —ve or both) if the desired magic constant is divisible without, leaving any remainder by the order of the square; otherwise, fractions will creep in.

Even-order magic squares

In general, the construction of even order magic squares is not simple. But, of all even order magic squares, construction of the 4th order magic square is the easiest and in fact easier than any odd-order square. Fig. 4 shows an empty 4th order magic square ready to be filled. The squares along the two diagonals are marked with two dotted lines which serve as guidelines.

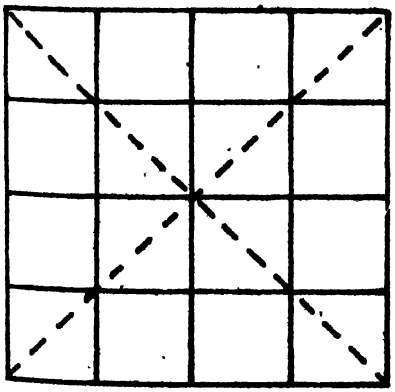

Fig. 4

Rule 1. To start with, remember not to fill any square carrying a guideline but for counting count as though these squares have been filled in, to fill in the other squares.

	2	3	
5			8
9			12
	14	15	

Fig. 5

Rule 2. Starting with the left-hand first square of the top row (remembering rule 1) fill in the squares horizontally to the right with consecutive numbers. When one row is over repeat the procedure for the row beneath the top row and in this manner fill in all the rows. Thus all the squares except the ones carrying the guidelines are filled up. Fig. 5 shows the squares filled up as per rules 1 and 2.

Rule 3. When all the squares not carrying the guidelines are filled . in, the squares carrying the guidelines are filled in, starting with the left hand first square of the top row. Fill it with the last number and then move horizontally counting backwards this time and filling the unfilled squares. Fig. 6 shows the completed 4th order square with the basic magic constant 34.

16	2	3	13
5	11	10	8
9	7	6	12
4	14	15	1

Fig. 6

Magic squares of even orders higher than 4 can be constructed by bordering the 4th order magic square. For example, the 6th order magic square can be constructed from the 4th order magic square in the following manner. For the 6th order square we need 20 numbers more than those required for the 4th order square (6^2-4^2). Therefore, each number in the 4th order square is increased by 10, i.e., 20/2. The 4th order square now contains numbers from 11 to 26. The numbers from 1 to 10 and 27 to 36 are arranged in in comlementary pairs as follows:

1	2	3	4	5	6	7	8	9	10
36	35	34	33	32	31	30	29	28	27

Any two complementary pairs are introduced into the diagonal corner of the 6th order spuare, the heart of which is the modified 4th order square. Then we select the numbers to fill in the top row and the left column so as to give the magic constant, which in this case is 111, and set their complements in the bottom row and the right column. Fig, 7 shows the 6th order magic square obtained by bordering the 4th order magic square.

By repeating this procedure of bordering, magic squares of higher even orders can be constructed. The selection of numbers to fill in the border row and the border column is by a trial and error method and this may be tedious.

36	2	3	7	32	31
4	26	12	13	23	33
9	15	21	20	18	28
29	19	17	16	22	8
27	14	24	25	11	10
6	35	34	30	5	1

Fig. 7

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How your tape recorder works

TAPE recorders, spool type or cassette type, are becoming increasingly popular and have, to a large extent, replaced record players.

Basically, a tape recorder consists of the following units:

1. A magnetic tape, 2. Recording unit, 3. Reproduction unit, 4. Erasure unit, and 5. Mechanical system.

Magnetic tape

Magnetic tape is a plastic tape having a thin magnetic coating of iron oxide. Each particle of iron oxide functions as a small magnet. In unmagnetised tape, these tiny magnets are distributed randomly and hence their combined magnetic field cancels out. If this magnetic tape is moved past a magnet then, because of the reorientation of these small particle sized magnets, some magnetization is produced along the moving tape which becomes magnetised. The magnetised tape is now associated with a magnetic field which is proportional in polarity and magnitude to the magnetising field.

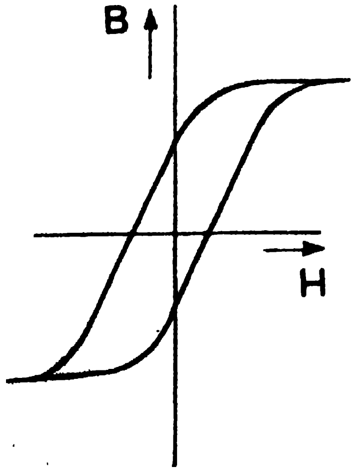

Fig. 1. Magnetisation Curve

Recording

If we speak before a microphone, electrical fluctuations corresponding to the spoken words are produced. These electrical fluctuations are called audio signals and form the recording signal. These audio signals are weak and hence need amplification. This boosting up of audio signal is done by 'Recording Amplifier'.

Now a tape has its own magnetisation curve (Fig. 1) and the audio signal should remain in the linear portion of this magnetisation curve. A deviation from this requirement leads to distortion and noise in recording. To keep the audio or the recording signal within the linear part of magnetisation curve of the tape, a bias-signal from a high frequency oscillator is used. Why do we use a.c. bias signal? Can't we use d.c. bias in its place? The answer is that of course d.c. bias can well be used for this purpose, but it has practically been found that a.c. signal does this job better than steady d.c. bias. High frequency of a.c. bias signal is used to avoid interference with the audio signal.

When this amplified audio signal, coupled with the high frequency bias signal, is applied to recording head which is a ring shaped electromagnet having a small gap between its two poles, the magnetic field at the gap (or the fringe flux) varies with the audio signal. When the tape moves past the poles of the recording head, constantly varying audio-signal and hence the magnetic field in the gap, it produces corresponding degrees of magnetisation along the moving tape. This is known as longitudinal magnetisation. A block diagram of the recording unit is shown in Fig. 2.

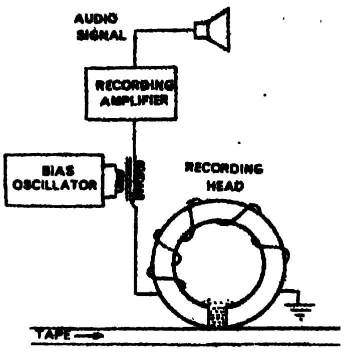

Fig. 3. Recording unit

Reproduction

'Whenever there is change in magnetic flux linked with a circuit, an induced e.m.f. opposing this change is produced in that circuit'— this is Faraday's law of induction. After moving past a recording head, the tape gets magnetised longitudinally and consequently develops a small magnetic field proportional in polarity and magnitude to the recording signal (or audio signal). When this magnetised tape moves

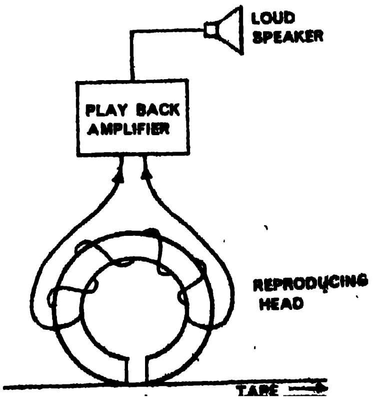

Fig. 3. Reproduction unit

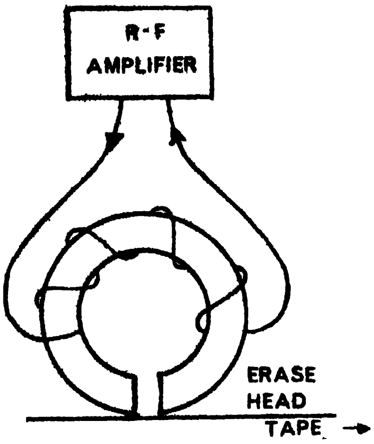

Fig. 4. Erasure unit

past the air gap of a 'Reproducing Head' which is also a ring magnet with a small air gap between poles, the continuously changing flux induces voltages in the windings of these reproducing head. The strength of this induced electrical signal varies proportionate to the variations in the magnetic field associated with the tape and the latter, as already mentioned, is proportional to the audio signal used in recording. But this induced electrical signal in the winding of reproducing head is very weak. Before it is fed to a loudspeaker for voice reproduction, it is amplified with the help of an audio-amplifier which is also known as play back amplifier.

Erasure

Suppose we have recorded some songs, and after some days we want to get rid of them and record some other songs. This new recording could, however, only be made if we can somehow wipe out the old recording. This problem of wiping out of old recording is solved by the third unit called 'Erasure'. An erasure is a ring shaped electromagnet. A strong magnetic field is produced by the use of a radio frequency oscillator. In this case also direct current could be used but with radio frequency field we get uniform and low noise erasure. Erasure Unit is shown in Fig. 4. The order in which these three heads are assembled is: Erasure (E), Recorder (REC), Reproducer (REP).

Mechanical unit

To move the tape at an even speed and with uniform pull past the three heads, a mechanical drive is provided. A good mechanical drive is costly. Generally, in hi-fidelity tape machines, two speeds of 19 cm per sec and 38 cm per sec are provided. Other sub-units of this drive mechanism are :

1. Supply reel, 2. Take up reel, 3. Idler pulley, 4. Capstan and Pressure roller, and 5. Idler.

A line sketch of the complete arrangement is shown in Fig. 5.

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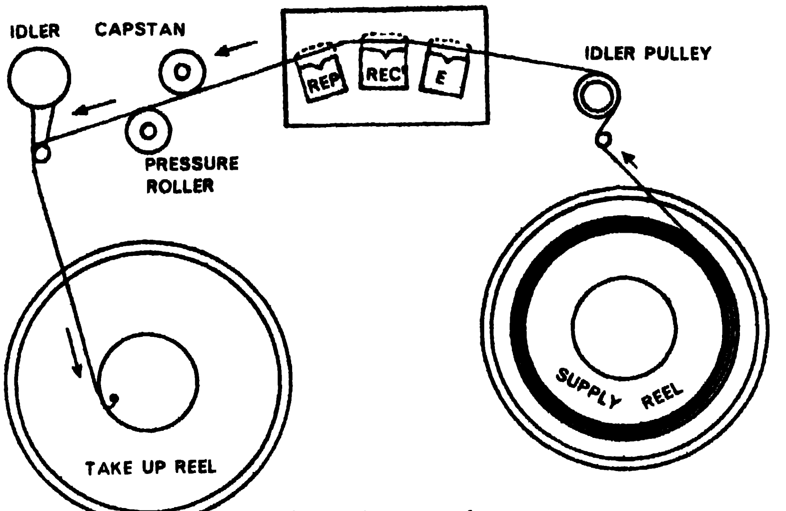
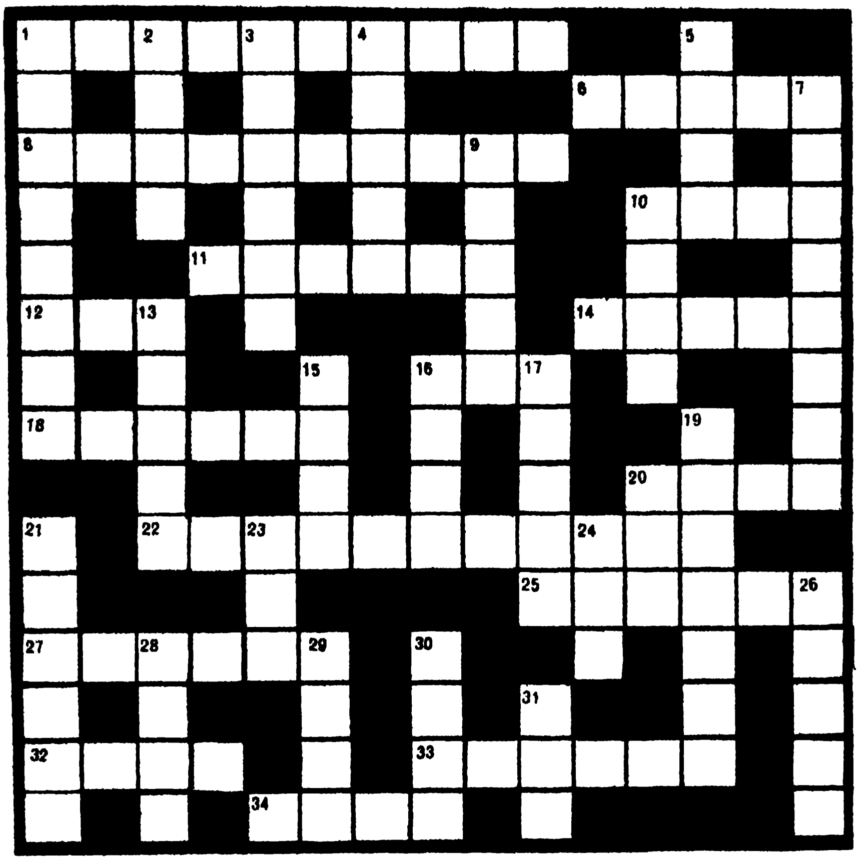


Fig. 5. Tape recorder

CORRIGENDUM

Ref: S.R., June 1977 (Do it at home: Mini Emergency Light), page 398, in Fig. 2, the resistor connected across terminal no. 1 and 2 is R_2. In text wherever 'grey' is mentioned *read* brown. The value of C_1=100 microfarad 10 volts, TR_1=AC128 with heat sink.

SCIENCE CROSSWORD PUZZLE (PHYSICS)



CLUES

Across

1. Study of phenomena at temperatures near absolute zero.
6. Permanent change in the dimensions of a material.
8. Instrument which shows variations in relative humidity of air.
10. Mobility of carriers in a semiconductor is known as—— mobility.
11. An interferometer used for studying fine spectrum lines.
12. Abbreviation for radio frequencies in the range 30,000-300,000 megahertz.
14. That it should be dark at night, seemed paradoxical to this German astronomer.
16. Abbreviation for a method of generating electricity by subjecting free electrons in an ionized gas to a magnetic field.
18. Moment of a force.
20. Smallest unit of area (used in subatomic physics).
22. Space is supposed to have this property.
25. A thermionic valve with three electrodes.
27. A product of work and time.
32. A transparent cell based on an effect of the same name which can be used as a high speed optical shutter.
33. A collective name for electrons, muons and neutrinos.
34. A device for selecting portions of a wave, either on a time or amplitude basis.

Down

1. The laser produces a powerful, monochromatic and —— beam of light.
2. A type of aerial used in television and radio astronomy.
3. False lines appearing in a line

■	1 H	U	M	U	S	■	■	■	2 E	B	B	■	3 C	O	4 C	O	A
■	Y	■	■	5 E	R	Y	T	6 H	E	M	A	■	■	■	O	■	■
7 L	E	E	K	■	■	■	■	A	L	■	■	8 P	9 O	P	P	Y	■
O	N	■	■	10 L	E	A	K	Y	■	■	■	■	11 P	O	R	K	■
12 D	A	R	W	I	N	■	■	■	■	■	■	■	13 J	V	O	R	14 Y
E	■	■	■	C	■	15 O	X	■	16 O	W	L	■	U	■	L	■	E
■	■	■	17 P	H	Y	S	A	18 L	I	A	■	■	M	■	I	■	L
19 M	■	■	■	E	■	■	■	A	■	■	■	20 T	■	■	T	■	P
A	■	21 G	22 O	N	D	23 S	■	T	■	24 J	■	E	■	25 E	E	L	■
M	■	U	I	■	■	O	■	I	■	A	■	26 R	A	M	■	■	27 C
28 M	I	L	K	■	29 A	W	■	30 M	A	W	■	M	■	■	31 D	■	U
O	■	32 L	O	O	N	■	33 K	E	R	A	T	I	N	■	O	■	B
T	■	■	34 S	L	U	G	■	R	■	■	■	35 T	O	D	D	Y	■
36 H	A	M	■	■	37 S	A	P	■	38 X	Y	L	E	M	■	39 O	A	K

Solution to Crossword Puzzle in June 1977

spectrum due to an imperfect grating.

4. **A calcite prism used for obtaining plane polarised light.**
5. **This transformation in radioactive decay involves a unit change of atomic number but no change of mass number.**
7. **Trade name for thin, transparent films which transmit plane polarised light.**
9. **The effect in which plasma constricts due to the magnetic field of a high current within the plasma.**
10. A luminous ring sometimes observed around the moon.
13. Unit of length in nuclear physics equal to 10^{-13} cm.
15. The——mass of a neutrino is zero.
16. Prefix denoting that a substance is optically inactive.
17. One-twelfth of the diameter of the sun or moon used to denote the extent of an eclipse.
19. A hypothetical particle of time which equals the time taken for light to traverse an electron.
21. Three hypothetical elementary particles supposed to be the basis of all matter.
23. Device which measures the distance covered by a vehicle is a ——meter.
24. An instrument based on the CRT which depicts varying electrical quantities.
26. The densest planet of our solar system.
28. Unit of pressure, equivalent to 1 mm of mercury.
29. A star which ejects a small part of its material in the form of a gas cloud.
30. Denotes absence of an electron in a semiconductor.
31. Abbreviation for the unit in a computer which processess input information and produces output information.

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Science Oddities

TRAVELLERS in Australia often use the extraordinary 'compass' nests of a species of termite to get their bearings. These huge mounds are as much as 3.66m high and 3.05m long, and are flattened from side to side. The oddest thing about these remarkable structures is that the narrow ends always point north-south, while the flat sides face east and west. No one is sure why the nests are invariably oriented in this fashion, but a tentative explanation is that it may prevent overheating of the mound by the noon sun, which would only strike the narrow top and not the sides.

LIFE on earth would be impossible without the sun which gives off an immense amount of energy part of which warms the earth and sustains the complex patterns of life on it. Less than one to two thousand-millionth of the total energy radiated by the sun is estimated to reach the earth, the rest is dissipated in space or absorbed by the atmosphere, etc. This seems to be about the optimum heat that life on earth can stand, for it has been calculated that if the sun's heat dropped by as little a 13%, the entire surface of earth would be covered by a mantle of ice more than a kilometre thick, while if it increased by about a third, all life on earth would be destroyed.

SHAPING a human being calls for an immense amount of information —from colour of eyes to curl of the hair, blood groups to body size, intellectual capacity to artistic ability —all this stated clearly and concisely so that there is no ambiguity. Unbelievable as it may seem, all these innumerable details are packed in the DNA molecule found in the chromosomes of the nucleus of every cell in the human body. Considering that each cell is so small that it is not visible to the naked eye, and the nucleus only a part of the cell, the amount of DNA it has should only be infinitesimal. Yet this minute structure, measured in hundred millionths of a milligram, carries coded within it all the millions of instructions embodying the blueprint of an entire human being. Translated into English, the coded instructions would fill over 100,000 pages of *Science Reporter*!

A plant uses very little of the water it takes in, while its loss by transpiration is phenomenal by comparison. It has been estimated that of about 234 litres of water absorbed by a maize plant, approximately 231 litres are lost into the atmosphere, while only the remaining 3 litres are actually utilised. In fact, a field of corn may, in a single growing season, give off enough water to cover the area to a depth of 40 centimeters or more. Even more wasteful is the silver maple: one individual tree was found to lose 261 litres of water in a single hour!

SCIENCE FOR THE YOUNG

THE feeling of being hungry or thirsty in animals (including man) is controlled primarily by the hypothalamus, a tiny body about the size of a grape, located on the underside of the brain. Injury to this region results in very peculiar effects on the animal's feeding habits. If one particular part of the hypothalamus is damaged, the animal, instead of being satisfied with its usual quota of food, gorges itself nonstop, till the food supply runs out or it is unable to swallow. Queerly enough, damage to another part of the hypothalamus, less than a centimeter away, results in the animal starving itself to death even if plenty of food is available!

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II

1. A single cell of *E. coli* (a bacterium) 1 μ in length and 0.5 μ in diameter contains a chromosomal DNA which is 1100 μ long.

2. One teaspoon of DNA of *E. coli* has an information capacity almost equal to that of a modern computer with a volume of about 100 cubic miles.

3. To isolate 1 gram of pure DNA polymerase (enzyme for DNA replication), Arthur Kornberg had to process 100 kilograms of *E. coli* cells. A single cell of *E. coli* weighs about 10^{-12} gram.

4. Actively growing cells of *E. coli* contain a normal complement of about 400 molecules each of about 2500 different proteins, 10-300 million molecules of about 1000 kinds of organic compounds and a variety of nucleic acids.

5. The total mass of microbial life on the earth is approximately 20 times the total mass of animal life.

7. A single bacterial cell that has a generation time of 20 min. would produce 2.2 × 10^{43} cells in 48 hrs. Weight of such a culture is equal to 24,000,000,000,000, 000,000,000,000 (24 × 10^{24}) tons. This mass is 4000 times greater than that of the entire earth.

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FOR HER (*Continued from page* 459)

diet developed retina degeneration that eventually could lead to blind- to measure all amino acids and be- they did not have refined techniques was ignored by researchers because bolize fats. Until recently, taurine ness. Cats like humans require taurine and do not produce it internally. Other experiments indicate that taurine plays a role in digestion and brain development. In human babies, taurine helps the body meta- cause early experiments in rats indicated taurine was unimportant. Rats unlike humans manufacture their own taurine. So while extrapolating results from animal models to human beings, utmost caution is required.

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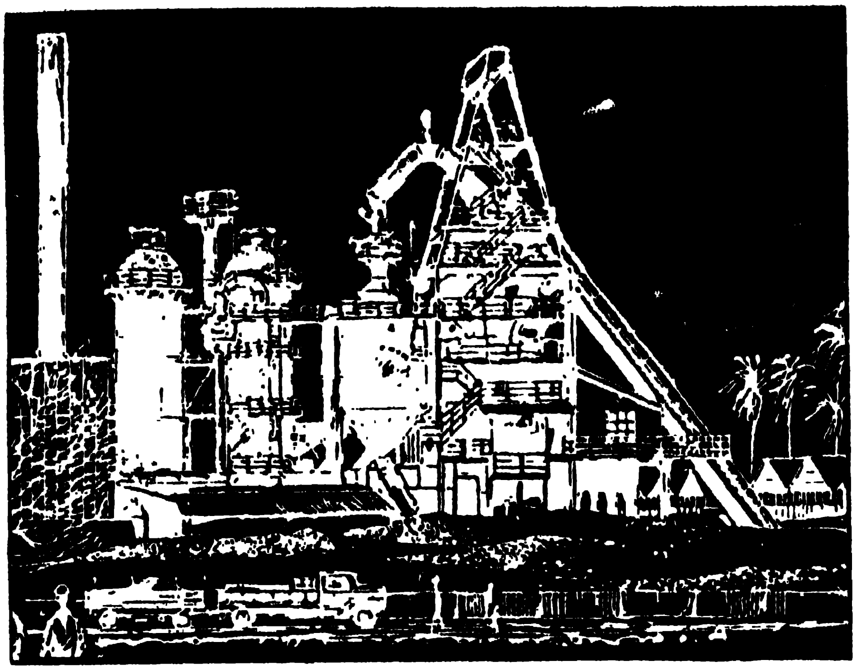

SCIENCE IN INDUSTRY

Desalination goes to villages

Water is an indispensable need of man and animal and is intimately associated with our evolution, civilisation and destiny. Abundant and good quality water invites settlement, agriculture pursuits and industrial activity. Though at present the supplies of water meet the demands of the country, problems of fresh water supply have already been faced and are going to arise more and more due to fast growing population, progressive industrialisation and rehabilitation of arid areas.

Simple desalination method for villages

In India there is perpetual shortage of potable water in arid, semiarid regions of Gujarat and Rajasthan and some coastal areas where the available sources of water are brackish or saline and potable water has to be supplied from long distances. The scientists and engineers of Central Salt and Marine Chemicals Research Institute, Bhavnagar have been investigating to explore possibilities of using indigenous know-how and hardware for the successful recovery of potable drinking water from saline waters. Two techniques developed by this Institute, viz., reverse osmosis and electrodialysis have been successfully utilised in rural areas of Gujarat to supply the potable water to small villages in Amreli district.

Extensive experiments in the laboratory and on field scale, show that, the techniques are viable to meet the small needs of potable water. The technology has by now been released to reputed water treatment plant manufacturers in India who are in a position to supply tailored plants.

During the summer months in the year 1973 acute potable water shortage was felt in district Amreli, Gujarat. The water table in the wells went down and the salinity increased to 4000 to 5000 parts per million total dissolved solids. The normal range should be within 500 ppm. The Institute undertook the opportunity to test the technology developed by it and selected two villages, viz., Rajasthali and Motagokharwada where small units of each of the processes, viz., reverse osmosis and electrodialysis were put into operation for meeting the drinking water needs of the villages. The units were successfully run and operated for a few months to supply potable water to the thousand thirsty villagers. This not only helped the people improve their health but also cut down their soap and sugar consumption.

Recent researches on salt

SOON after independence, Central Salt & Marine Chemicals Research Institute Bhavnagar came into being in 1954 as a result of recommendations of salt experts in the country. There was an urgent need for upgrading the quality of salt and increase in yield per acre due to continuous demand of good quality salt for alkali and chemical industry as well as exports. There was also need to develop processes for the preparation of refined salt for variety of uses, viz, for dairy (butter and cheese), pharmaceuticals, chemical analysis, food canning, etc., which was imported to meet the country's requirements.

The scientists of the C.S.M.C.R.I., Bhavnagar have evolved many technologies which have helped in the growth and development of salt industry in India.

For winning good quality and better yield, the salt works have to be laid out on scientific basis. The Institute has rendered technical assistance to numerous big and small salt works in India and even abroad as West Africa and Saudi Arabia. A special variety of free flowing table salt having rounded salt crystals and unique free flowing properties has been developed and this process is under commercial exploitation.

Common salt has been considered to be a very useful and convenient vehicle for iodine, calcium and iron. Health salts, viz., iodised salt, calcium and iron fortified salt are required to combat various diseases like endemic goitre, weak bones and anemia.

The fortified salts prepared have undergone extensive nutritional trials on human and animal subjects.

Like the mineral fortified salt for humans the Institute has also developed a know-how to prepare self setting salt block to be used as cattle licks, fortified with salt and trace elements like zinc, manganese, iron, cobalt, etc., which not only improves the general health of cattle, but also helps increase yield of milk at a negligible cost. Cattle licks will certainly take care of the undernourished cattle in our country.

MEDICAL NOTES

(*Continued from page 458*)

available which could dissolve gall-stones, and the patient had to undergo surgery. High doses of the antibiotic neomycine sulphate have been found to cause dissolution of gall-stones in rabbits, but the effect on human stones is yet to be observed. C. Michael Seidel and Evan H. Crook, scientists of Rohm & Haas Co., U. S. A. have recently patented a new preparation which they claim can dissolve cholesterol gall-stones and can lower the serum cholesterol content. Their preparation consists mainly of certain macro-reticular resins (*U. S. Patent*, No. 3,962, 420/June 8, 1976).

A new drug for the dissolution of human gall-stones was also marketed in Germany in 1974. Researchers of this drug say that it will help obviate surgical removal of the offending gall bladder which is otherwise the only means of treatment so far. Ulrich Leuschner of Frankfurt University says that the new drug has a success rate of 30 and 60 per cent. Prescribed in capsule form, the drug will dissolve gall-stones with a cholesterol content of over 70 per cent. Despite the advantages of the new drug, it may be prescribed only for those sufferers who want to avoid surgery and can afford the very high cost of the drug treatment which has to continue for at least one year.

Z. R. Vlahcevic, D. H. Gregory, and L. Swell, at the Department of Medicine, Medical College, Virginia, Richmond (USA), have now proposed the use of a barbiturate "phenobarbital" for the dissolution of cholesterol gall-stones (*Amer. J. Dig. Dis.*, **21**, 429-435, 1976).

Just as old age is creeping on apace,
And clouds come o'er the sunset of our day,
They kindly leave us, though not quite alone,
But in good company— the gout or stone.

—George Gordon Byron

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BOOK REVIEWS

THE RADIO UNIVERSE by J. S. Hey, ***Pergamon Press***, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 264, $ 15.50.

IT'S a story of radio astronomy, though certainly not in chronological order, from the detection of radio signals from cosmos in 1933 to the recent past, when radio waves have become so much omnipresent as to engulf the entire universe. And add to it, the story is told by one who has witnessed this swelling of radio astronomy from almost the beginning. He is, in fact, the first scientist, then working for Army during the World War II, who recognised the radio emission from the sun in 1942. The book is therefore a first hand account of radio astronomy as it grew before the eyes of a pioneer. However, as expected in such a case, it doesn't contain a single element of drama or romance. It is a book, in accord with its aim to popularise radio astronomy, written with detachment and in a straight forward language. From cover to cover the book gradually unravels the mysteries surrounding this so-called glamorous subject.

Mystery surrounds a subject when a layman, or for that matter, a scientist of any other discipline, is told, particularly in newspaper style. that this is a radio galaxy with this much temperature; radio telescope is a giant which can detect a star smaller than a second of an arc; synchrontron radiation is a fantastic messenger from various heavenly objects; so on, so forth. Naturally, a layman is left in wonderment. He ponders over all this and eventually shrugs his shoulders, saying it must be something beyond his capacities, which is why the 'why' of it has not been explained. The book under review is commendable in that it doesn't allow any doubt or mystery to linger any more in a layman's mind. On reading the 'whys' given in a simple and easy-to-follow manner, he would immediately say "Oh! This is so easy. I had never imagined." He gets to know how the most sophisticated telescope functions, how the temperature of heavenly bodies could be judged from the radio waves it is emitting, how the various mysteries in the universe could be solved by studying radio astronomy, etc. In short, the book is well suited to a layman with a scientific bent of mind and who knows basic mathematics.

The book could also serve to refresh a researcher working in the field about the latest developments in various aspects of radio astronomy. Some unsolved problems are also mentioned here and there to bring them to the notice of such researchers. Appendices on various related subjects such as radio receiver, scales of measurement, useful data, are also given for those interested to know more.

The book is well illustrated and nicely produced. It is however highly priced. Let the publisher bring out its paperback edition and provide it to the Indian readers at a nominal price. In the next edition some mistakes need to be taken into consideration. There should be uniformity in giving the names of scientists : all be mentioned with their first names or initials. On page 90, Io is called planet instead of satellite. The photograph on page 68 is not clear. On pages 202 and 204 the figure no. 9.7 should read 9.9.

DILIP M. SALWI

PRINCIPLES OF DAIRY PROCESSING by James N. Warner, *Wiley Eastern Limited*, AB-8. Safdarjang Enclave, New Delhi-110016. Pp. 317. Rs. 22.00.

WHILE the author's earlier work, *Dairy in India*, dealt with milk-producing animals, milk processing and milk products, the present volume deals with dairy processing as a large scale industry.

No longer would students have to go through piles of research papers, monographs and journals in order to learn about relatively well-established and well-accepted facts on the subject. Beginning with a chapter on India's dairy processing industry, the author takes an interdisciplinary approach and deals with the microbiological, physical and mathematical aspects involved in dairy processing. The factors involved in designing dairy processing plants, the equipment layout, have all been discussed at length. Many recent concepts and findings have been incorporated like the calculation of the pollution factor, calculation of the solubility of casein in milk of different breeds of Indian cow and the effect of homogenization and pasteurization on surface tension and curd tension of buffalo milk. Entire chapters have been devoted to discussions on different forms (fluid milk, concentrated milk, dried milk) and products (i.e., cream and butter, ghee, icecream, cheese, cultured milk and casein) of milk.

What makes this a good textbook is the way the author builds up the theme from first definitions. Designed primarily for dairy technologists required to man the expanding dairy processing industry in India, it would be of help to research scientists in the field. An exhaustive bibliography appended at the end adds to the merit of the book.

RATNABALI MITRA

CHORDATE EMBRYOLOGY by P. S. Verma, V. K. Agarwal & B. S. Tyagi, Second Edition (1976) S. Chand Ram & Co., Ram Nagar, New Delhi, Pp. 383, Rs. 10.00.

RAPID developments in the field of genetics, cytology, biochemistry, embryology, etc., in the last few decades made us to realize the utmost significance of embryology in understanding various problems of the life. The old descriptive embryology, therefore, has been combined with dynamic experimental physiological approach, or more correctly an altogether a new branch called, the developmental biology, has come forth.

The book under review is intended for beginners who wish to understand the fundamentals of developmental biology. The whole gamut of subject has been described in a simple and systematic manner suited for readers who have not been exposed sufficiently to the subject. The authors have tried to put more emphasis on morphological approach but, nevertheless, a few aspects of cell biology, biochemistry and endocrinology are freely discussed at appropriate instances. These instances are enough to keep the arguments down to earth and so reduce the confusion in grasping the subject. The five new chapters in this second edition further strengthen and enhanc the integrated spectrum of descriptive-morphological and experimental-physiological approach of the text subject matter.

The text starts with a good introductory chapter which briefly describes the history of embryology including its basic laws and required techniques. Six chapters are devoted to embryogenesis of individual chordates, and others to general account. Above all the text, a mere compilation of many standard sources, comparising .of 20 chapters, is well linked.

In summary, the book may be recommended as a concise, lucid and simple text good for beginners. The topics dealing with non-chordate embryology have been described in various chapters, especially in the five newly incorporated ones in this second edition. However, the title of book does not indicate this important aspect and so it would be better to modify the title accordingly. Further, the inclusion of an altogether new chapter on embryogenesis of invertebrates, specially insects, and more comparative account in other chapters would definitely make the book more helpful.

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Delhi-110007

REACTION MECHANISM IN ORGANIC CHEMISTRY by S. M. Mukherji and S. P. Singh, *The Macmillan Company of India Ltd.*, 2/10, Ansari Road, New Delhi-2, 1976, pp. 388, Rs. 24.00.

THE book under review deals with various types of organic reactions and their mechanisms. It is intended for students who have had a basic course in organic chemistry at undergraduate level. Opening chapter of the book discusses the concepts of atomic orbitals, molecular orbitals perturbation, molecular orbital method and their applications to the phenomena of resonance and aromaticity, etc. But the PMO treatment of aromaticity at this stage is an unnecessary extension. Reagents reaction intermediates and general principles and methods of determination of reaction mechanism have been developed in the following chapters. Rest of the chapters deal with different classes of organic reactions such as nucleophilic substitution, addition to carbon-carbon multiple bonds, elimination reactions, reactions of carbonyl group, molecular rearrangements, etc. The approach of the book has been quite classical in all these chapters. Interesting ideas of conservation of orbital symmetry have been discussed in the chapter on pericyclic reactions. Perturbation molecular method for the analysis of pericyclic reactions has also been discussed. Authors have brought out a good book for chemistry students who want to have an insight into the how and why's of different organic reactions.

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MODERN PHYSICS by M. L. Sisodia, N. C. Jain and S. M. Khamesra, *Ramesh Book Depot*, Jaipur, pp. 344, Rs. 15.00.

The growth of science has been very rapid in the last three hundred years. The fundamental laws and basic ideas have accordingly had to be revised so completely that the twentieth century physics has come to be treated as Modern Physics. With the introduction of three year degree course, this interesting branch of physics seems to occupy a lesser place as compared with other branches of physics owing to want of books.

The book under review is written to cover the syllabus prescribed for the final year students of three year degree course of most of the Indian Universities.

The book has been divided into thirteen chapters, which include electron physics, atomic physics, nuclear physics and elements of vacuum tube electronics. In the last chapter, elements of special theory of relativity have been discussed. The book has an appendix divided into seven parts. It includes general theory of electron discharge in gases, tables showing the values of various physical constants and commonly used radioisotopes, etc.

The subject matter has been presented in a simple and understandable language. Solved numerical examples are given in every chapter to understand the applications of these topics.

In most of the chapters a few micro-topics of vital importance are missing. The theoretical treatment in the book lacks requisite depth. Many experiments have not been given and discussed properly to simplify the subject. However, each chapter consists of fairly large number of suitable problems and probable questions to enable the students to gain confidence.

The book may be useful for students of final year of three year degree course.

R. S. GUPTA
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MODERN PHYSICS AND ELECTRONICS by R. C. Bhandari, M. L. Sisodia and N. C. Jain, *Ramesh Book Depot*, Jaipur, Pp. 379, Rs. 16.00.

THE book under review, as the authors claim, is for the final year classes of three year degree course of Indian Universities. The book is divided into two parts: (1) Modern physics; and (2) Electronics. In the part on modern physics, the positive rays and mass spectrograph, atomic structure, photoelectric effect and X-rays, laser elements of radioactivity, radiation particle detectors and the special theory of relativity have been described.

The part on electronics includes the electron emission and vacuum tubes. The semiconductor diodes and transistors have been included. The tube and transistor amplifier characteristics have been presented. Although written in an elementary manner, the chapter on elements of radio communication has become a mess of modulation, detection, antenna, receivers and ionosphere.

The book contains a number of solved and unsolved problems which demand sound knowledge of the subject. The book is unindexed and without references. The language of the book is simple. A few diagrams are confusing. Nevertheless, a good correlation exists among all the chapter.

The book is of use to B.Sc. students.

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BOOKS RECEIVED

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2. **PROBABILITY AND STATISTICS** by Mathai & Rathie, *Macmillan Co. of India*, 2/10, Ansari Road, New Delhi-110002, Pp 406, Rs. 48.00.
3. **HEREDITY AND EVOLUTION** by M.S. Mani, *Oxford & IBH Publishing Co.*, 66, Janpath, New Delhi-110001, Pp. 158, Rs. 20.00.
4. **ANIMAL ECOLOGY** by Gupta and Malik, *Pragati Prakashan*, P. B.No. 62, Meerut-250001, U.P., Pp. 152, Rs. 6.60.
5. **BUILDING SCIENTIFIC INSTITUTIONS IN INDIA : SAHA AND BHABHA** by Robert S. Anderson, Occasional Paper Series No. 11, *Centre for Developing Area Studies*, McGill University, Montreal, Quebec, Canada, Pp. 122,Rs. 16 or $ 2.00.
6. **STATISTICS IN ACTION** by Peter Sprent *Penguin books*, Indian Representative: *Penguin Overseas Ltd.*, 706 Eros Apartment, 56 Nehru Place, New Delhi-110024, Pp.240. £. 1
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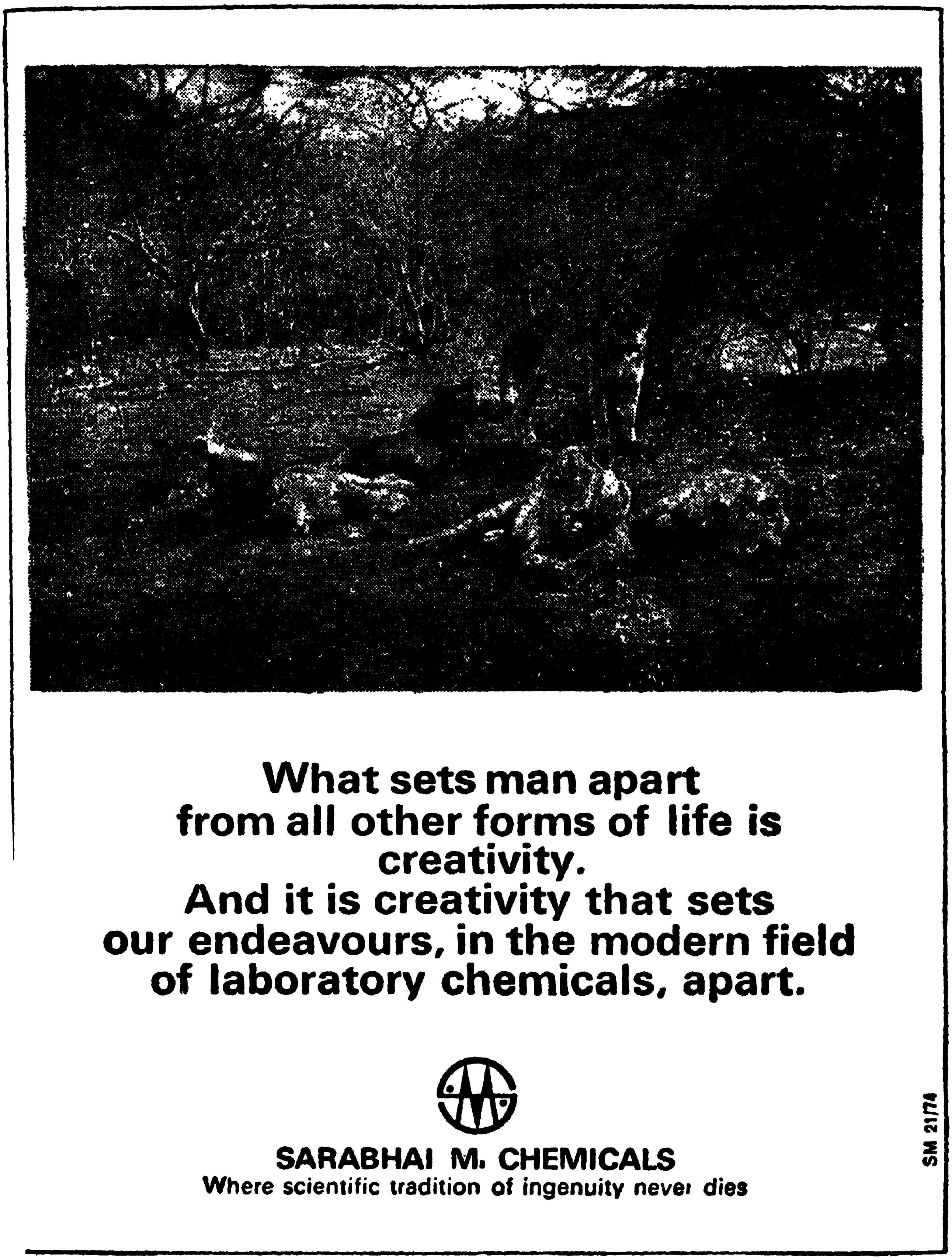

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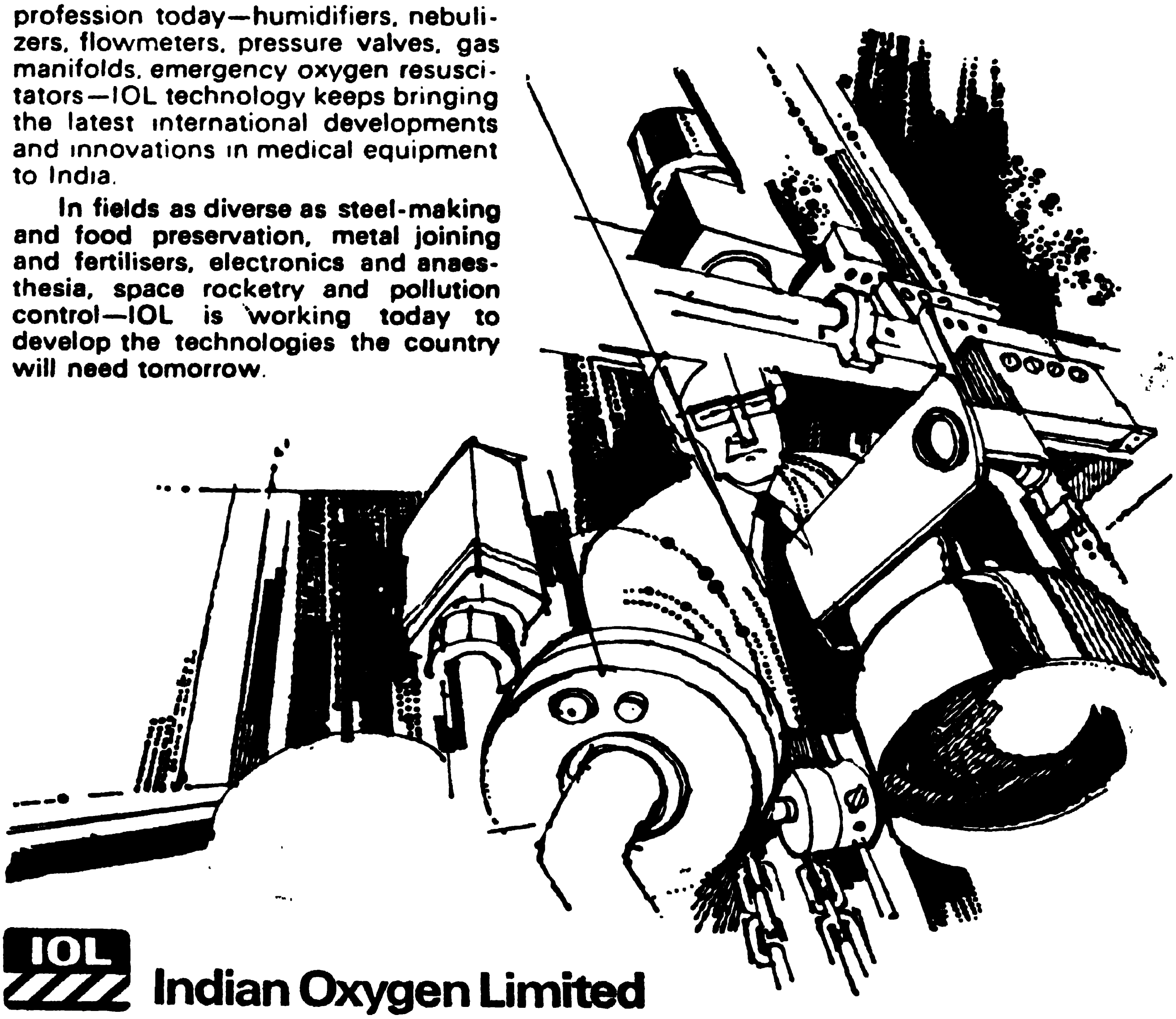

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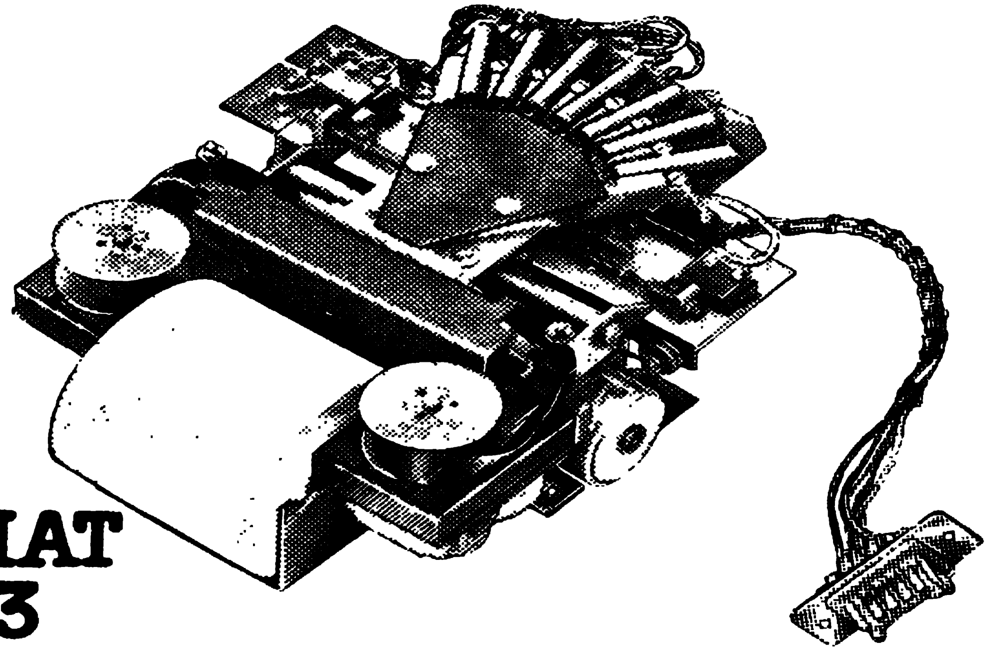

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COVER: (*Left*) **A small portion of coastline in Goa at low tide, (*right*) the same at high tide. Tidal range is about 2 m**

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LETTERS

Vitamin C

Sir, I read with interest **Vitamin C** under Science Spectrum (*S.R.*, Dec. 1976) wherein S.Ramakrishnan has given an account of the association of the vitamin with a number of human diseases and concluded that "a person *with normal metabolism* can conveniently go in daily for 1 gm to 2 gm of vitamin C to look young, to ward off diseases and to be healthy".

"*Vitamin C—myth or miracle?*" by Geoffrey H. Bourne of the Yerkes Regional Primate Centre, Emory University, Atlanta, Georgia, U.S.A., reprinted in *AROGYA*—Journal of Health Sciences (Manipal), 1975, Vol. 1, pp. 9-19, raised some pertinent points about the use of vitamin C in large doses. One argument against the regular intake of large doses of vitamin C is that once the body has adapted to these large doses, it will always require them.

Requirement of vitamins has been largely based on nutritional studies on animals as well as humans at different stages of growth. Daily allowances for a person have been recommended by Food and Nutrition Board of National Research Councils of different countries. None has advocated more than 200 mg daily intake under any stage of human growth and normal health. During the past two decades greater understanding of biochemistry of diseases has been gained and the possible role of vitamin C under various disease conditions of the human body has also been studied. Higher pharmaco-therapeutic doses from 500 mg to 2 gm are recommended till one's return to normal health. No need to continue such high doses after return to normal health.

Further, modern researches have shown that massive doses of vitamin C have the potential to interfere with drug metabolism and thus alter the pharmacologic effect of other drugs given at the same time. Modification of drug biotransformation by vitamin C in man has been the topic of recent studies (*Nature*, May 1, 1975).

More important is the finding about the substantial destruction of vitamin B_{12} by ascorbic acid in high doses. It is reported that iron and vitamin C given in large doses at mealtimes could lead to vitamin B_{12} deficiency (*The Year Book of Drug Therapy*, 1976, p. 68). It is well-known that vitamin B_{12} plays its very significant role in microgram quantities, and so it is not desirable to bring about B_{12} deficiency by taking more than the minimum required amount of vitamin C for normal health conditions.

It is also to be borne in mind how far vitamin C is retained in the body due to its high excretion rate and whether regular use of large doses of vitamin C daily may not lead to alteration in normal renal functions. Ascorbic acid may acidify the urine and contribute to renal calculi formation especially in people who have a tendency to gout or show increasing excretion of cystine in the urine. Further, oxalic acid is formed metabolically from ascorbic acid and so huge doses of vitamin C are likely to lead to an increase in the incidence of the urinary tract calculi composed of oxalic acid (G. H. Bourne. *loc cit.*)

Still another point for serious consideration from our national, socio-economic conditions will be whether the majority of Indians can afford to go in for this large dose (so essential ?), much less to mention the scarcity of the vitamin, at times, in the market due to inadequate production in our country. One would like to know if the present ambitious suggestion from a non-clinical biochemist for the intake of 1-2 gm ascorbic acid daily would have the approval of clinical experts and nutritional advisers.

The rich will rush for more from the market and the poor will be hit to a great extent!

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Man made gene

Sir, In the article **Can man make a gene?** (*S.R.*, March 1977) the following corrections would benefit the readers:

1. The authors have not clarified that gene is defined as a part of DNA that contains information for specifying complete amino acid sequence of one polypeptide chain. The 'one-gene-one protein' hypothesis holds true only in the cases where one type of polypeptide chain constitutes a complete protein molecule. Frequently however, two or more types of polypeptide chains must join together to form an active protein. For example, haemoglobin contains four polypeptide chains. Two are of one type called alpha chains (α) and two are of a different type called beta chains (β). The α and β chains are controlled by two different genes which are not even linked.

"However defining gene precisely and fully has become difficult because the primary effect of gene is not always a polypeptide. Genes also code for *t*RNA, *r*RNA or are simply functional, acting as controlling segments of operons, e.g., operator and promoter regions."

2. To say that only one DNA strand acts as template for RNA synthesis is not correct. Only one DNA strand along a gene acts as template for RNA. So at any specific region

only one DNA strand is transcribed. That means in a cell both strands of DNA in a particular chromosome are transcribed but one strand acts as template for some genes while the other strand transcribes some other genes.

3. There are exceptions to the fact that RNA is a single stranded molecule. Some viruses have a double stranded helical form of RNA as the genetic material; for example, reoviruses, rice dwarf virus, wound tumor virus.

RAKESH TULI
Scientific Officer, Bhabha Atomic Res. Centre, Trombay, Bombay

1. "One gene—one polypeptide chain" hypothesis does not have much relevance to the main features of our article Therefore, a detailed discussion on the subject has deliberately been avoided. It was thought sufficient to generalize this subject by saying that a particular nucleotide sequence or a segment of DNA is responsible for synthesis of a particular protein.

To say that "defining gene precisely and fully has become difficult", is probably not valid in the light of arguments now available. Indeed, certain genes direct the formation of ribosomal and transfer-RNA molecules and not the formation of protein; but this reservation does not mean that genes act in two different ways. They in fact direct the formation of protein molecules by ways not other than that of RNA molecules. However, "it seems more appropriate to define the term gene at the particular functional level being considered with the proviso that the gene is a section of genetic material determining this function. In terms of proteins, therefore, it is useful and commonly accepted to consider a gene as the section of DNA that determines a polypeptide since it is the polypeptide that is the basic unit characterizing the function of a particular protein" (Strickberger, M. W., *Genetics*, Colier Macmillan Publishers, London, Pp. 914, 1976). Further, we have come across another very simple definition of the gene. Those regions of the genome transcribing the messenger-RNA (which would ultimately be translated into proteins) are called the *structural genes*. The other regions, coding for the different ribosomal RNAs and transfer RNAs, are generally called the *determinants for RNA*.

2. Nowhere in our article we have written "that only one DNA strand acts as template for RNA synthesis" as Mr. Tuli has pointed out. Instead we have said that "In living cells, only one strand ('sense strand') of DNA serves as a template along which the nucleotides of RNA are lined up according to the complementary rules to form RNAs" (column 3rd, page 163). A "sense strand" means "only one DNA strand along a gene". Therefore, the correction suggested is not needed as whatever he wants to say has already been said; only a deep insight is needed.

It is not logical even to presume that both the strands of DNA are transcribed for a particular gene because only one strand "makes sense" phenotypically. If both strands along a gene are transcribed, then, both *m*RNAs will be complementary to each each other. Since both the *m*RNAs are complementary, they will hybridize to form a double stranded structure. Consequently no protein synthesis will occur as the single-strandedness of *m*RNA is essential for translation. However, transcribable regions can be found on both strands (see Szybalski. W H. kubioski and P. Sheldrick. (1966) in Cold Spring Harbor Symposia on Quantitative Biology 31; 123 and D.S., Hogness, W. Doerfler, J. B. Egan, and L. W. Lack (1966) in Cold Spring Harbor Symposia on Quantitative Biology 31: 129).

We would like to update the statement as "in a cell both strands of DNA in a particular chromosome are transcribed but one strand acts as template for some genes ***at a particular time or developmental stage*** while the other strand ***may*** transcribe some other genes *at some other time or developmental stage*".

An easy inference that can be drawn from the above statements is that the genetic information for the synthesis of a complete product (whether protein, *r*RNA or *t*RNA) is transcribed from one particular strand of DNA (or a specific gene) at a particular stage. But this is not so in *some* cases of *t*RNA. Studies with DNAs whose strands can be separated show that *t*RNA transcribes some segments from *one strand* and other segments of the same molecule from the *other strand* (Davis, B. D. *et al.* 1973, *Microbiology*, Harper and Row, London, Pp. 1562). This means that for one *t*RNA molecule both strands of DNA can be the "sense" strands.

3. Our article does in fact take care of the point raised that "There are exceptions to the fact that RNA is a single stranded molecule." We request the attention of Mr. Tuli where we have written that "Molecules of RNA are single stranded, linear polymers of mononucleotides. Although certain types partially assume a secondary double helix configuration through complementary base pairing."

Admittedly, however, we did not mention another important exception where single stranded DNA molecule acts as genetic material, which Mr. Tuli has also failed to point out. The examples are, phage *ox* 174, filamentous coliphage *fd* and M13, etc. This single stranded DNA genome is of the same polarity as the *m*RNA. No virus with single stranded DNA complementary to *m*RNA has yet been found, although viruses with strands of both polarity in separate (viral) particulars have been characterized

(Crawford, L. V. 1969, the DNA of a minute virus of mice, *J. Gen. Virol*; 4: 37-46). However, we may mention that these exceptions, whether of RNA or DNA, do not have any relevance to the article.

SUBHASH S. ARORA
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Haryana Agricultural University
Hissar-125004
(MISS) KAREN SANSI
Department of Animal Genetics
NDRI (ICAR) Karnal

Exceptional *Azadirachta indica*

Sir, The plant *Azadirachta indica* (Syn. *Melia azadirachta*) belongs to the family Meliaceae. It is a perennial tree having pinnately compound leaves which have ovate shape and serrate margin. It has a normal tap root system.

The leaves of this medicinally important plant usually taste bitter, but there is an exceptional plant of the species near Lunibahal, 2 km. from Purunakatak High School in the District of Phulbani, Orissa, the leaves of which do not have the usual bitterness. What factors are normally responsible for the bittertaste of the leaves of *Azadirachta indica* and under what circumstances this variation has occurred may be a new fact. In the surrounding other trees of the same species have the usual leaves having bitter taste.

This exceptional *Azadirachta indica* tree has been discovered very recently, i.e., in the month of January 1977. This is not the flowering season of the plant and yet we have collected and kept some of the herbaria with much care. In the flowering season we will keep some more herbaria. We have collected also three soil samples from near the tree.

Any explanation for this newly discovered fact will be welcome.

Moreover, we would like to request you to publish an elaborate up-to-date article on *Azadirachta indica*, more specifically on the cause of the bitterness of the leaves and other parts.

VIJAYA KUMAR PRADHAN
SUSHIL KUMAR PRADHAN
High School, Purunakatak-762013
Dist. Phulbani (Orissa)

Indian Science Congress

Sir, The letter of V. K. Pandit (*S.R.*, May 1977) under the above caption is thought provoking. Every year in the first week of January, the Indian Science Congress, held under the auspices of some university, goes through the routine business of a pompous inauguration, sectional meetings, symposia and some special lectures. The Association has about 6000 members, and its annual conference is attended by more than 2000 scientists, some of them from abroad.

When the inauguration ceremony is over, and the VIP's and many of the top scientists have gone, the delegate-scientists divide themselves into some 13 sections representing as many major disciplines of science. In recent years the number of research papers presented in the different sectional meetings of the Congress has reached 2000. And it is during the reading of these papers and the discussions which follow that the organisational inadequacies come to the fore and conditions become chaotic. When I attended the 1975 Congress at Delhi, a lecture on "Differential Biology" was delivered in the mathematics section. Many of the participants were not at all interested in the subject. They were simply chatting with each other. Even the president of the mathematics section who was in the chair evinced little interest in the subject. He was busy with some other papers. Outside the lecture hall, too, the delegates not interested in the lecture made much noise which disturbed those attending the lecture.

The scientists themselves are to blame for the mess they have made of the Science Congress. The Congress is no longer a forum for presenting new findings. And why should a serious research worker present his paper in this "annual get-together" when he can easily get it published elsewhere? Many serious scientists had a bitter experience of this annual show. "At Bombay (1960), the Science Congress", J.B.S. Haldane had remarked, "appeared to be an organised conspiracy against originality in Indian Science." Never a person for mincing words, J.B.S. had also spoken about the malice that affects the Science Congress: "The root cause of all this incompetence and worse is not far to seek. A large number of Indian scientists have no pride in their profession, though they are proud of their salaries and positions. The opposite attitude is common in Europe, as it was in ancient India. I have seen a member of the Council of the Royal Society (R. A. Maccance, to be precise) turn up at a Council meeting in shabby clothes with his luggage on his back in a knapsack. In India today the unworthy successors of Durvasa and Visvamitra actually invite governors, Vice-Chancellors, and the like to address them. . .".

G. M. NATARAJAN
Biology Department
Coimbatore Medical College
Coimbatore-641014

All about alfalfa

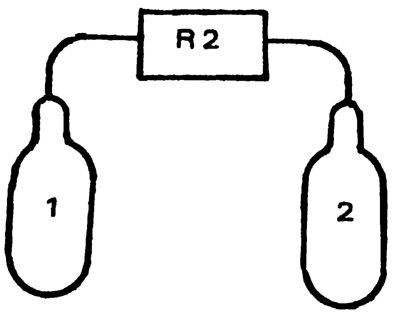
Sir, I read the article *All about alfalfa* by D. C. S. Raju (*S.R.*, March 1977) with much interest. To a botanist, the information given in the article is quite satisfactory. But in homoeopathy, it is not only a tonic but also a remedy for deficient lactation diabetis insipidus, phosphaturia, neurasthenia, splachnic blues, nervousness, insomnia and also it promotes appetite and improves mental and physical vigor.

SACHIDANANDA PARIDA
D.H.M.S. (*Utkal*)
Udala (*Orissa*)

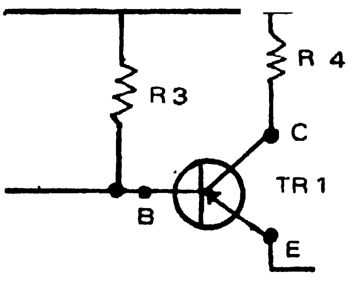
Mini emergency light (*S.R.*, June 1977)

Sir, I have carried out some improvement to avoid heating up of components which costs only 30 Paise more.

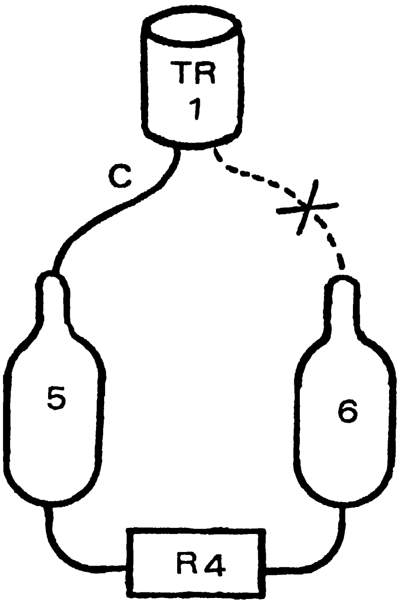
1. The value of electrolytic capacitor C_1 is 100 microfared 12 volts.
2. The value of R_2 is 100K (*not* 10K)



3. To overcome the heating effect in long run connect 390 ohms Resistor (R_4) at the Collector of TR_1 as shown below.



4. Near by Values of Resistors can also be used.



5. A heat sink on TR_3 can be used (it is not a must)

B. SHANKAR RAO
Technical Supervisor
Inspectorate of Systems
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Hyderabad-500005

DIRAC (*Continued from page 498*)

back. Thanks to Miss Dent and the depression, the choice had been made for him. And just eleven years later he succeeded Sir Joseph Larmer as Lucasian Professor of Mathematics in Cambridge, a chair whose first occupant was Issac Barrow, Newton's teacher, and the second, Newton himself.

Dirac was born on August 8,1902, at Bristol. He was educated at the Merchant Venturers' Secondary School, Bristol, and at Bristol University where he studied electrical engineering and obtained B.Sc degree in 1921. He spent the next two years at Bristol studying mathematics and then went to St. John's College, Cambridge, as a research student in mathematics. He obtained his Ph. D. degree at Cambridge in 1926 and the following year was elected a Fellow of St. John's College.

Since 1926 Dirac has travelled extensively and has studied at various foreign universities, including Copenhagen, Gottingen, Leiden, Wisconsin, Michigan and Princeton. He was a visiting lecturer at the University of Wisconsin and University of Michigan (1929) and Princeton Universities (1931). He then returned to Cambridge where in 1932 he became Lucasian Professor of Mathematics. During 1947-48 and again in 1958-59, he was a member of the Institute for Advanced Studies, Princeton, N. J. He is Professor Emeritius, Professor of Physics at Florida State University since 1971.

Dirac was elected a Fellow of the Royal Society of London in 1930 and was awarded the Royal Medal in 1939. In 1933 he was awarded the Nobel Prize in Physics. In 1938 he received the James Scott Prize of the Royal Society of Edinburgh. In 1952 he was awarded the Copley Medal of the Royal Society of London and the Max Planck Medal by the German Physical Society.

Dirac is the author of *Principles of Quantum Mechanics* and *General Theory of Relativity*.

Further reading

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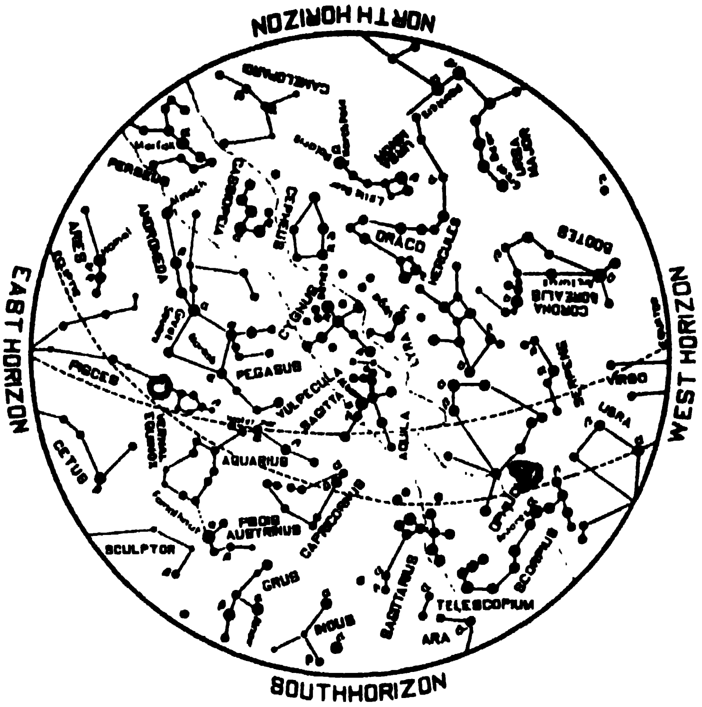
2. Heathcote, Niels H. de V. (1953), *Noble Prize Winners in Physics*, Henry Schuman, N.Y.
3. Mehra, Jagdish (Editor) (1973), *The Physicist's Conception of Nature*, D. Reidel Publishing Company, Holland/U.S.A.
4. The Nobel Foundation (Editor) (1962), *Nobel, the Man and his Prizes*, Elsevier Publishing Company, Amsterdam/London/NY.
5. Dirac, P.A.M. (1974), *Proc. R. Soc. A338*, 439.

Planets and their positions

SEPTEMBER 1977



MAGNITUDES
-1 0 +1 +2 +3 +4 +5

MOON
☽ – FIRST QUARTER 20th
O – FULL MOON 27th

The moon

NEW moon occurs on 13th at 2-53 p.m. and full moon on 27th at 1.47 p.m. I.S.T. The moon passes about four and a half degrees south of Jupiter and five degrees south of Mars on 7th, five degrees south of Venus and about five and a half degree south of Saturn on 11th and about two degrees south of Mercury on 12th. The lunar crescent becomes first visible after the new moon day in the evening of 15th.

The moon is at apogee or farthest from the earth on 5th and at perigee or nearest to it on 18th. The sun is at the autumnal equinox on 23rd.

The planets

Mercury (Budha) is too near the sun to be visible during the first half of the month. It is in inferior conjunction on the 5th. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It becomes direct on 14th and is at the greatest western elongation of about 18 degrees from the sun on 21st. It is in Leo (*Simha*). Its visual magnitude varies from +1.8 to − 1.0.

Venus (Sukra), visible in the morning sky, rises about two hours before sunrise during the month. It passes about half a degree south of Saturn in the evening of 18th. It also passes very close to the star Regulus (*Magha*) on 22nd. It moves from Cancer (*Karkata*) to Leo (*Simha*). Its visual magnitude is about -3.4

Mars (Mangala), a morning star, rises about half an hour after local midnight during the month. It passes about half a degree north of Jupiter in the early hours of 5th. It is in Gemini (*Mithuna*). Its visual magnitude is about +0.9.

Jupiter (Brihaspati), visible in the morning sky, rises about half an hour after local midnight during the first half of the month and at about local midnight during the second half. It is in quadrature with the sun on 28th. It is in Gemini (*Mithuna*). Its visual magnitude is about −1.8.

Saturn (Sani), a morning star, rises about one and a half hours before sunrise during the first half of the month and two and a half hours before it during the second half. It moves from Cancer (*Karkata*) to Leo (*Simha*). Its visual magnitude is about +0.8.

(*Source*. Nautical Almanac Unit of the Meteorological office, P-546, Block 'N; (1st floor) New Alipore, Calcutta-53).

TIDAL POWER
Its potential and scope in India

It is now possible to harness tidal energy and bring in "blue coal" to India

C. K. GOPINATHAN
S. Z. QASIM

Introduction

HUMAN progress has often been judged from the ways in which man has been able to develop and harness energy, and the overall development of a nation is estimated from the total amount of energy it produces and consumes in relation to its size and population. The energy demand of man has been on the increase since the dawn of history, but a sharp increase in human population has resulted in a much greater demand for energy. With the affluence of a country, the per capita demand for energy goes on increasing, and today a single American consumes as much energy in his everyday life as probably 50-100 Indians.

Petroleum hydrocarbons (oil and gas) have been thought to be one of the best sources of energy. But our needs for energy have gone up so much that even if we pool all

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Dr. Qasim is Director, National Institute of Oceanography, Goa; Shri Gopinathan is Scientist at the Institute.

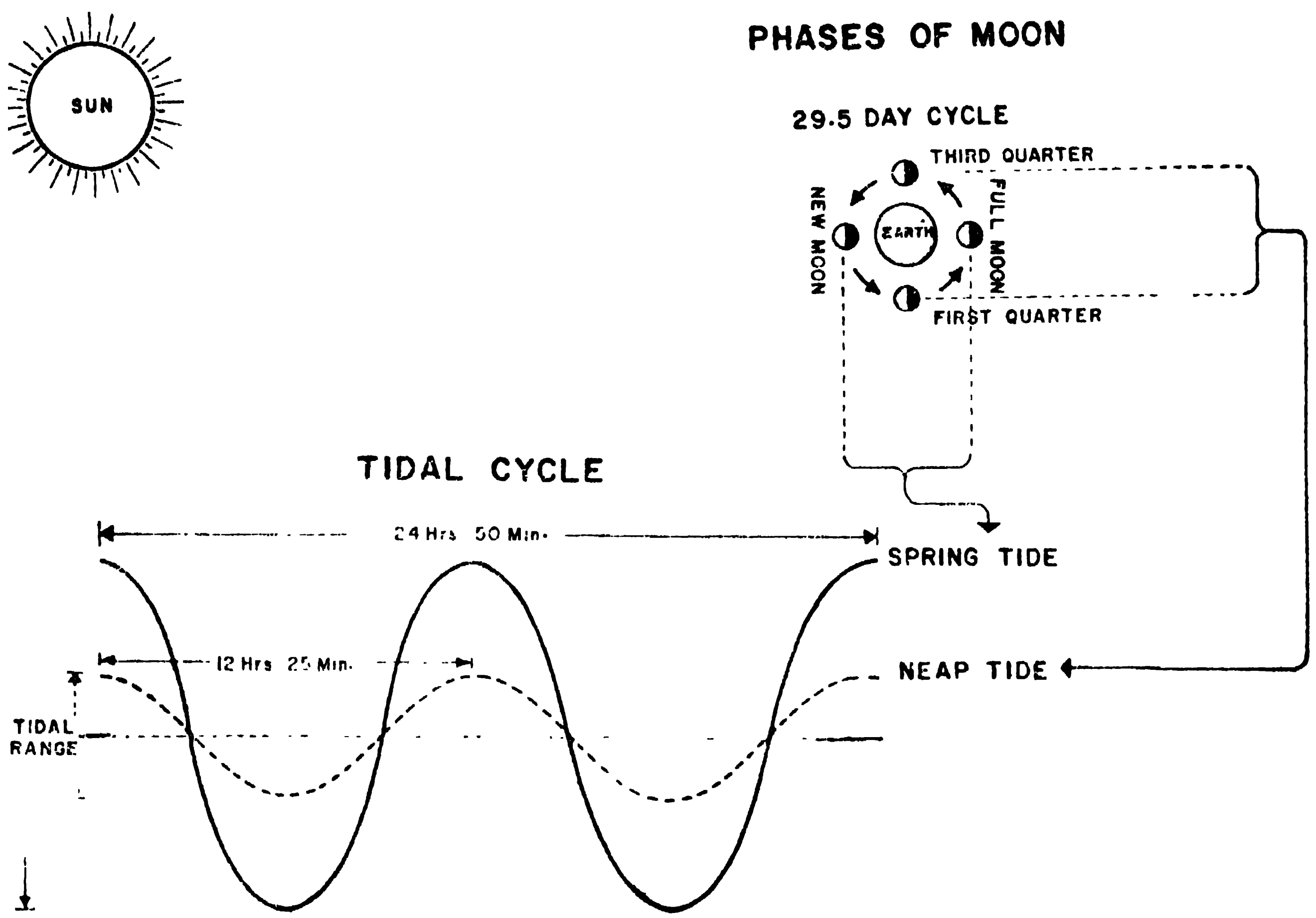


Fig 1 Classical explanation of tidal rhythm—spring and neap tides. During spring, when the sun, moon and earth are in one direction, the range is maximum. During neap, when the moon is away from the sun and the earth, the range is minimum

the sources of power known today, such as oil and gas, coal, hydropower and atomic power, etc., they would prove to be totally insufficient in the long run

The most important consideration connected with fossil reserves (oil, gas, coal, etc.) is its depletable nature. According to experts, any exhaustible resource extracted from the ground, in the face of increasing demand, results into a cycle. This cycle starts at zero production, increases exponentially, then decreases exponentially and finally comes to zero. The exploitation of petroleum reserve of the world is likely to reach its peak by about 1990, and by the year 2020 about 90 % of the total source of petroleum in the world would finish.

The awareness, therefore, of the depletable source of energy is forcing many nations to seek such alternate sources of energy as are unconventional and inexhaustible. In this context, two sources of energy - solar and tidal—have been thought to be most promising.

The sea is a storehouse of several kinds of energy. There is energy in the waves, energy in the temperature difference of the water column, energy in the currents and so on. But we still do not know how to utilise these sources of energy economically.

About 20 years ago, similar was the case with tidal energy, although from the historical records it appears that a long time ago some utilization of tidal energy was made by setting up of tide-mills. However, today we know how to make use of tidal energy, largely because of the ingenuity and persistent efforts of French scientists and engineers. In the past, many persons contributed to the problem of tidal power utilisation, but the most outstanding work was of the French engineer, R. Gibrat, who first developed the theory of flexible and controllable utilisation of tidal energy and finally implemented it in the form of a tidal power plant built over the river Rance in France. Further solutions of some of the most complicated problems connected with the utilisation of tidal power came from other

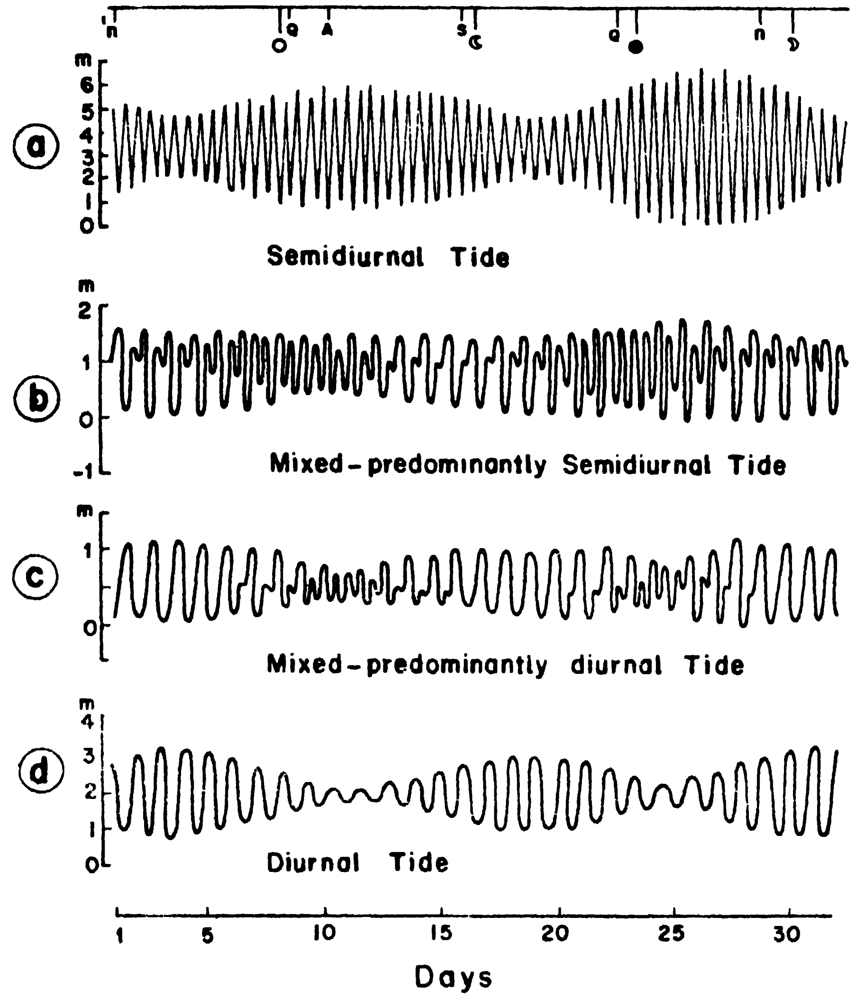


Fig. 2. Types of tides occurring in the coastal areas of India. Time in days is given below in relation to the phases of the moon shown on top

French engineers—Kamerlochez, Casacci and Rowille who developed the idea of reversible flow, bulb-housed turbine systems.

What is tidal power?

Every person living near the sea has noticed that the sea in the inshore and coastal areas rises and falls in a rhythmic fashion. The water in the adjoining bays and estuaries also oscillates up and down from the mean sea level. The flow of water, associated with the rise and fall in coastal area and bays, gets advanced and retarded with the incoming and outgoing tides respectively. When the water at a place is much above the mean sea level, it is called flood tide, and when the level is much below the mean level, it is called ebb tide. If a dam is constructed in such a way that a bay or basin gets separated from the sea and a difference in the water levels is obtained between the basin and the sea, power can be generated from this difference using low head turbines.

Tidal power in the form of electricity is obtained from the oscillatory flow of water during filling and emptying of a nearly closed coastal basin by the tides. There are a number of schemes for tidal power generation.

The construction of power house, sluice-way and dykes is essential to tidal power plants. The most important factor is the design and construction of a generating unit consisting of low head turbines. It took the French engineers nearly 20 years to develop a bulb-type reversible turbine. It is a compact machine which can serve as a turbine during the flow of water in both directions without reversing the position of the turbine. It acts as a motor when electricity is supplied to it. And it can also work as a pump in two directions, or, as a gate regulating the flow of water in either direction.

Advantages and disadvantages of tidal power plants

Tidal power plants—TPPs for short—have their own advantages and disadvantages. Their important advantages are that they replenish themselves, they are absolutely pollution free, and their overall monthly or annual output of power remains constant. There is no chance factor involved in their power generation because the tide will always come and it will always have a definite and predictable range.

In contrast to this, the other types of plants, such as thermal or atomic power plants, constantly require raw materials for their replenishment and they are well-known for their pollution problems. Similarly, the hydroelectric power plants are also known for their large seasonal and yearly fluctuations in the output of energy because they are entirely dependent upon nature's cycle of rainfall, river flow, water storage, etc.

The cost of construction of a tidal power plant is largely dependent upon its location. If its location is favourable as is the case of French tidal power plant at Rance, the cost of power production would be similar to that of the hydroelectric power. Another important advantage of tidal power is that it has a unique capacity to meet the peak power demand effectively when it works in

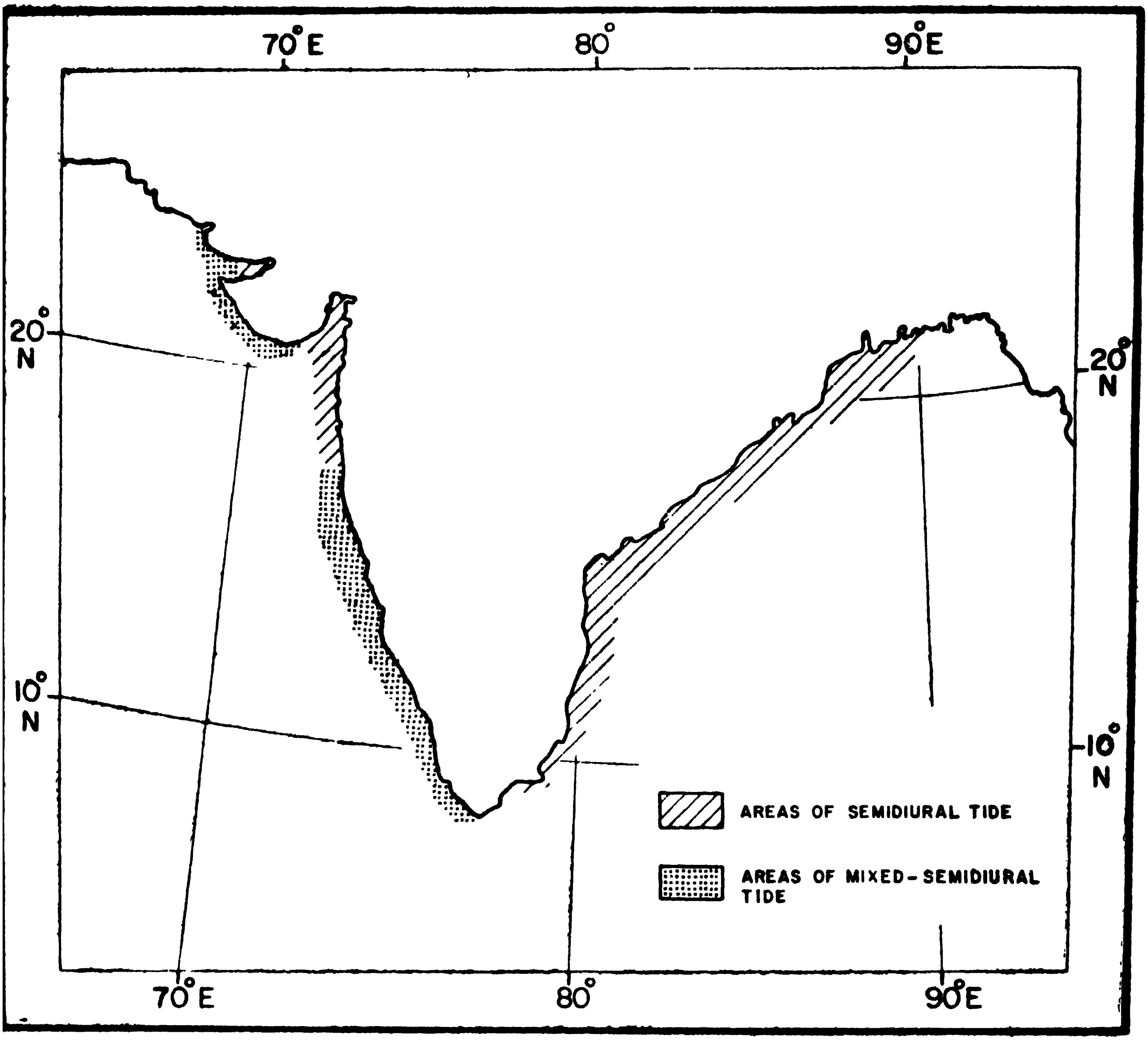


Fig. 3. Types of tides found along the Indian coastline

combination with thermal or hydroelectric plants.

The other benefits of TPPs include recreational facilities to visitors and holiday makers (as Rance Power Plant), elimination of unwanted flooding, possibility of fish farming in tidal basins and excellent road transport over the tidal barrage.

However, the TPP does not directly provide an alternative to thermal or atomic power plants, but can only supplement the other types of plants effectively. Large variations in the tidal range at fortnightly intervals and the high cost of construction of the plant are some of the constraints in the development of tidal power.

Moreover, the serious limitations in the tidal power production are the lack of suitable tidal characteristics in many coastal areas for the construction of TPPs economically and the sophisticated nature of machinery required for power generation. It is interesting to note that the output of power from a TPP varies with the lunar cycle, because the moon largely influences the tidal rhythm, whereas our daily power requirement is directly related to solar cycle. In addition to this, the daily power supply obtained from a TPP also varies intermittently. The other draw-back in the tidal power is that the utilisation of tidal energy on a small scale has not yet proved economical.

Major categories of tides

The oceanic water masses of the earth respond to the tide generating

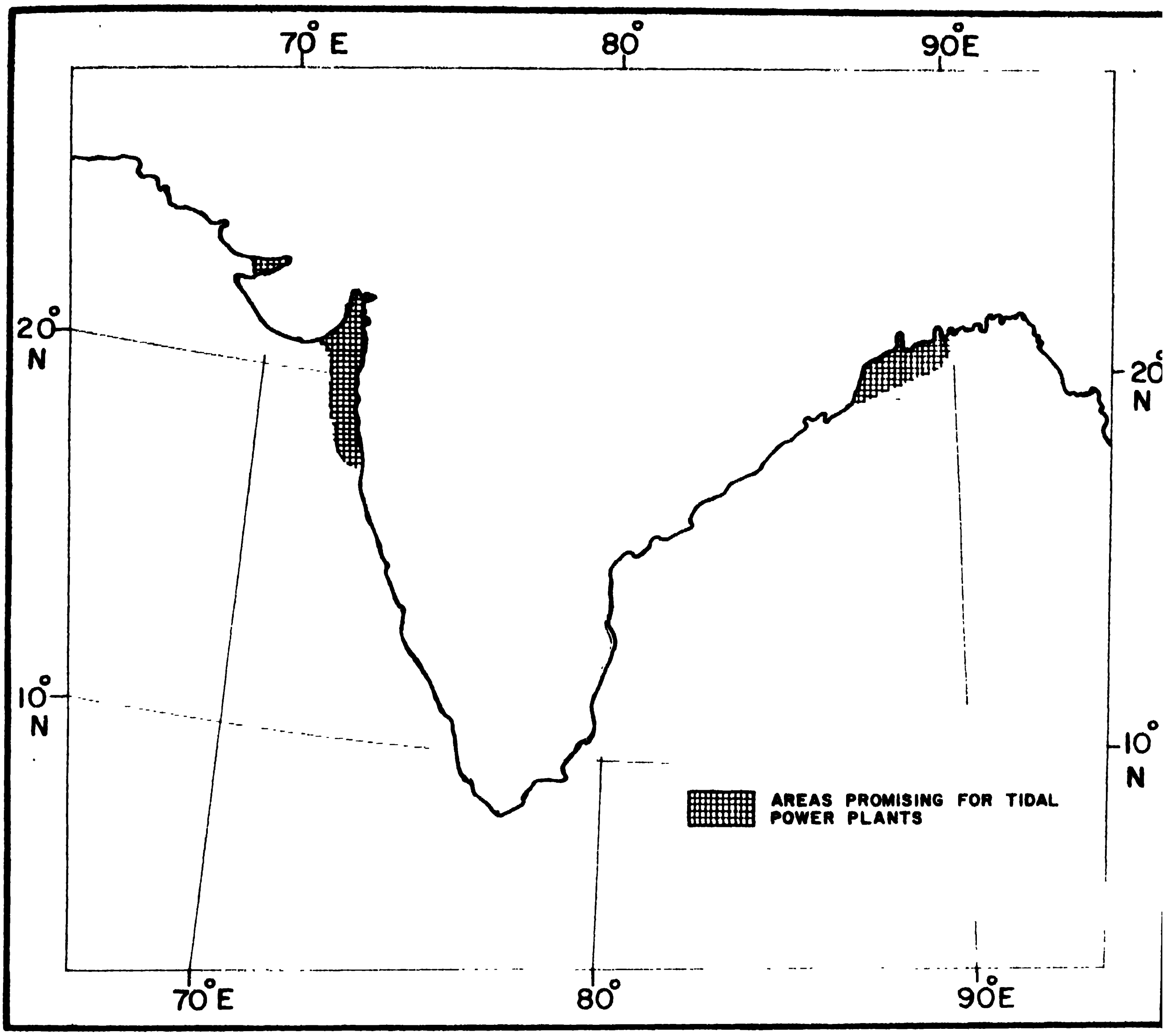


Fig. 4. Some areas along the Indian coastline which are promising for tidal power generation

forces of the moon and the sun in a very complex manner. According to the classical theory of tides, if the entire surface of the earth happens to be covered with water, there will be only two floods and two ebb tides of equal magnitude, about 50 cm in range, daily all along the oceans. But in reality it is not so. The tides in a coastal area may belong to any one of the following four categories :

In areas where lunar influence is predominant, the tide is called semidiurnal. This has two high waters and two low waters daily, with a negligible change in the level between the two consecutive high and low waters. The duration of rise and fall in the water is nearly equal. In this type of tidal cycle, large ranges occur close to the period of full moon and new moon and they are called spring tides. Similarly, smaller ranges occur close to the 1st and 3rd quarters of the moon and they are called neap tides (Fig. 1). The shape of a 30 days marigram of this type of tide is shown in Fig. 2(a).

The second important category of tides is diurnal. Here also the water level varies sinusoidally, but the tidal range is small and only one high water and one low water occur daily (Fig. 2, d)

In the other two categories of tides [(Fig 2(b) and 2(c)] a combination of the two extremes, i.e., semidiurnal and diurnal tides, are found. They are mixed tides, either predominantly semi-diurnal or diurnal, depending upon whether the influence of the former or the latter is predominant. The shapes

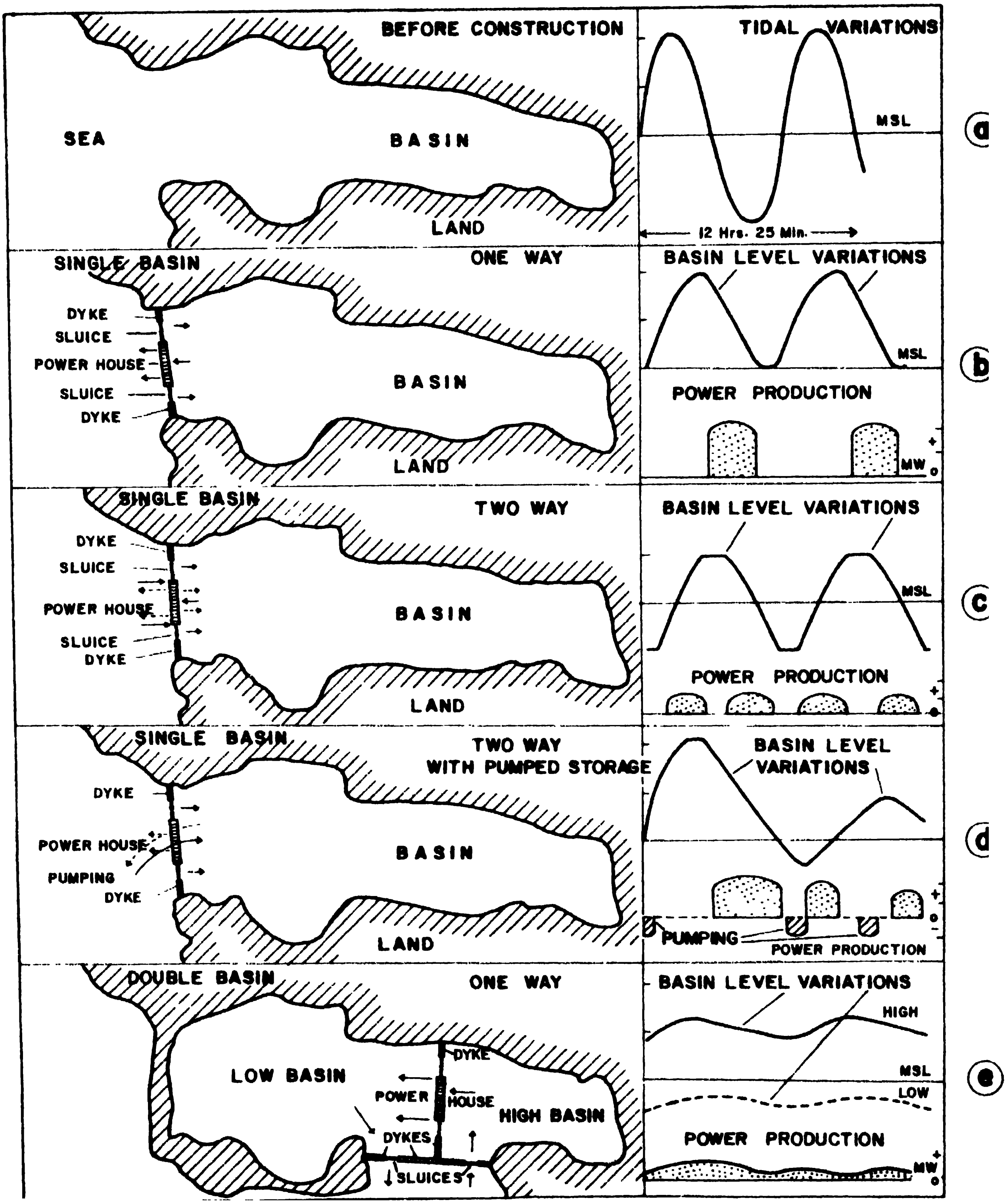


Fig. 5. Some schemes of tidal power generation

of the marigrams in a mixed but predominantly semidiurnal and another mixed but predominantly diurnal types of tides are shown in Figs. 2(b) and 2(c). The regions along the Indian coast where various types of tides are found have been shown in Fig. 3.

Suitability of an area for tidal power

The suitability of a locality for tidal power generation largely depends on the type of tides available in that area, the characteristics and range of the tides and their possible effect on the associated engineering works. The semidiurnal tide is known to be best suited for the generation of tidal power economically.

Tidal power can be generated only if a difference could be introduced in the water level (differential head) of two predetermined basins - one of which is normally the sea. A tide with a minimum average neap range of 90 cm is essential for power generation. Areas where the average of the total tidal range is smaller than 5 metres are unlikely to be of much value for power generation on a large scale: although theoretically it is possible to design plants in areas with a smaller tidal range.

The average neap range and the average of the total range of semidiurnal type of tides along the Indian coastline are given in Table 1. It is clear from the Table that places, where the average tidal range of 3m to 6.7m occurs, are found along the Gujarat and West Bengal coasts. These places are most promising for a large scale power generation. However as regards the suitability of a site and other related factors, the tidal range alone may not be the only deciding factor. In China, as far as we know, most of the TPPs make use of the minimum neap range of 90 cm. If this is true, then several other places in our country could be considered for tidal power generation. Moreover, the maximum utilization of energy sources from the tides would mean that we may have to go even for smaller TPPs incurring perhaps much higher costs per unit of power generation. Some of the areas in India which are quite promising for TPPs are shown in Fig. 4.

Table 1. Places along the Indian coastline where semidiurnal tides occur. The average range of neap tides and the average of the total range of tide at each place are given.

Places	Average neap tidal range (metres)	Average total tidal range (metres)
Kandla	3.98	4.94
Navalakhi	4.02	5.23
Bhavnagar	4.79	6.77
Bombay	1.44	2.55
Tuticorin	0.16	0.43
Pamban Pass	0.16	0.38
Nagapatnam	0.27	0.45
Madras	0.41	0.71
Kakinada	0.53	0.94
Visakhapatnam	0.54	0.99
Paradeep	0.70	1.29
Shortts Island	0.99	1.88
Chand bali	1.03	1.55
Sagar	1.60	2.95
Haldia	2.08	3.52
Diamond Harbour	2.19	3.53
Garden Reach	2.06	3.11

In a hydroelectric project, the power potential of a basin is expressed in terms of discharge rate and the head. In the case of a TPP, the power potential is expressed in terms of basin area in km² and the tidal range in metres.

Assuming that there are no surface gradients, i.e., when the basin gets filled instantaneously with the incoming tide, the work done by the tide during the flood and ebb cycles would be the product of the weight of water raised and lowered by the tide. Thus, according to Bernshtein, a Russian authority on the subject, the annual energy potential (E_p) of a tidal basin is:

$$E_p = 1.97 \times 10^6 H^2A \text{ kilowatt hours.}$$

where H is the tidal range and A is the area of the basin.

In calculating the power potential, two important assumptions are involved, i.e., the basin area during the course of the tidal cycle remains constant, and the dimension of the basin located in the direction of the tidal wave is equal to or smaller than half of the tidal wavelength.

Principles of tidal power generation

Power generation from the tides can be obtained in the following ways.

Single basin -one way. This is the simplest form of tidal power generation. In this case, during the flood tide, a basin is allowed to get filled, and during the ebb tide, when the water flows from the basin to the sea, fixed blade turbines are used for the generation of power. The power in this type of plant is only available for a short duration, i.e., during the ebb tide. Fig. 5(a) shows a single tidal basin before the construction of a dam and Fig. 5(b) indicates the diagrammatic representation of a dam at the mouth of the basin and power production during the falling tide.

Single basin—two ways. Here power is generated both during the flood and the ebb tidal flows. In this type of plant, variable pitch turbines and dual rotation-generators are used to produce power. The output of power is intermittent but of a

"We know how to generate power from the tides, but the problem is that we need power to generate tides in the sea at all times and in all seasons."

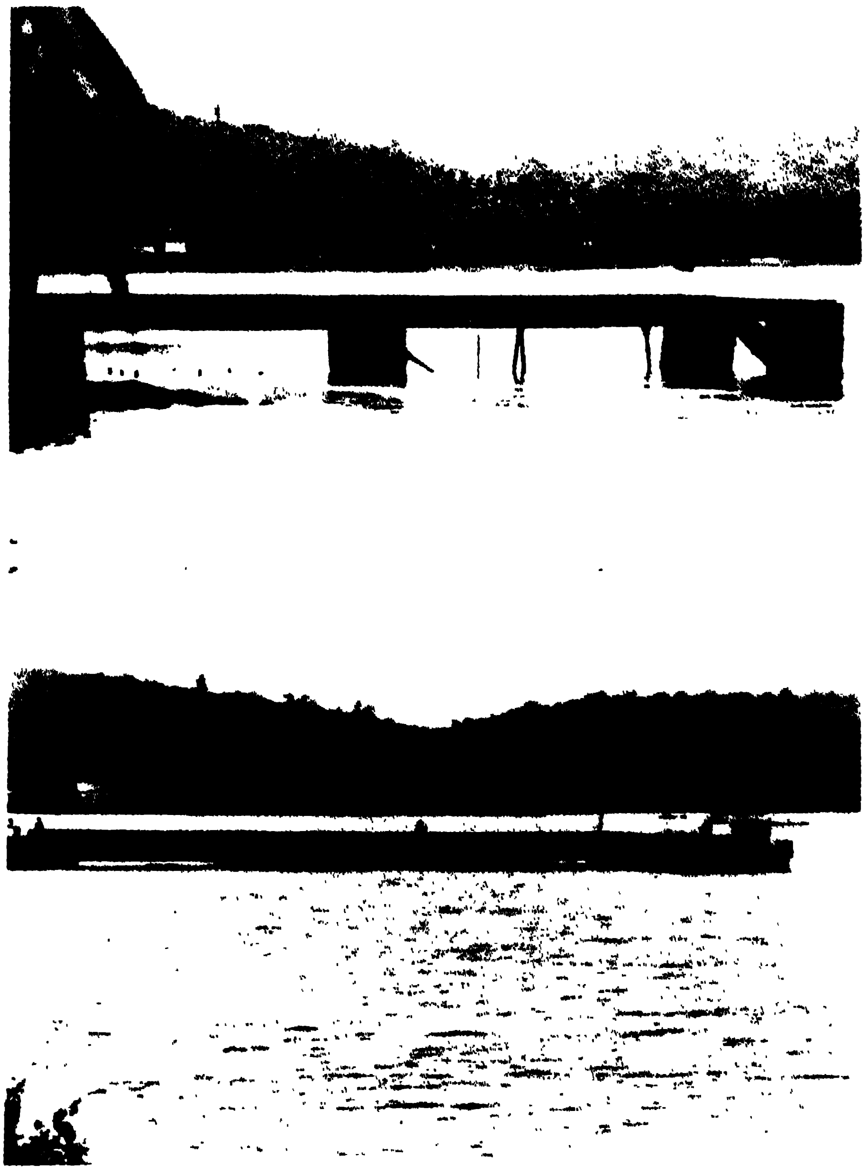


Fig 7 (Top) A jetty in Goa at low tide (bottom) The same jetty at high tide with a boat berthed along side. Tidal range is about 2m

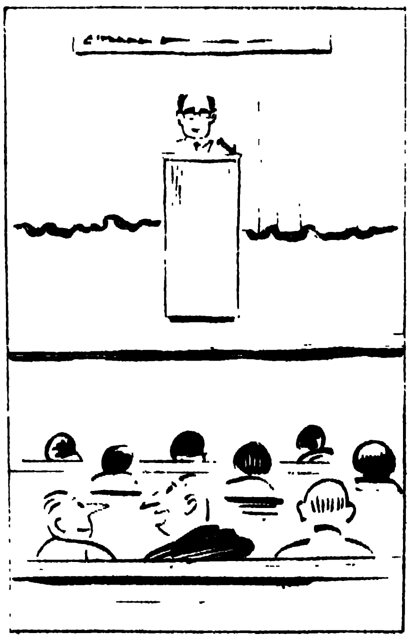
longer duration as compared to the 'single basin one way' scheme (Fig 5) However, the peak power obtained in this case is less than the former

Single basin two way with pumped storage The French TPP at Rance is of this type Here power is generated both during flood and ebb tidal flows Complex machines capable of generating power and pumping the water in either directions are used A part of the energy produced is used for introducing the difference in the water levels between the basin and the sea at any time of the tide and this is done by pumping water into the reservoir up or down. In this type of plant, continuous power can be produced for a much longer duration [(see Fig. 5 (d)] than the other two schemes mentioned above

Double basin (De Cour type). In this scheme, the turbines are set up in between the two basins. One basin is intermittently filled by the flood tide and the other is intermittently drained by the ebb tide So, a small but continuous power is made available by the tides [(Fig. 5 (e)] But during this process, half of the potential energy is sacrificed in introducing the variation in the water levels of the two basins The cost of construction of a double basin plant is quite prohibitive

Double basin with pumping from off-peak systems In this case, off-peak power from some other power plant is used either to pump the water up the high basin or to pump the water down in the low basin If the pumping head is lower than the basin-to-basin turbine generating head, an energy gain is possible The construction of this scheme is also relatively expensive

A few other schemes for tidal power generation have been suggested. According to them, power can be suplied as a function of solard time, and not necessarily as a function of lunar time. But most of these schemes are very expensive to implement. One such system is called the De cour scheme. Of all the systems planned so far to produce intermittent power, the most



"He is pouring out words in torrents"
Yes, "he is talking on tidal power"

successful and efficient is the single basin—two way scheme [Fig. 5 (c)].

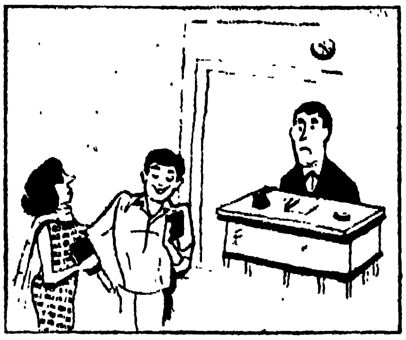
Tidal power plants of the world

Although many countries including India have the capability of utilising tidal energy, only three nations have succeeded in putting up TPPs—largely on a pilot scale. France was the first country to complete a small pilot TPP in 1957. Taliang TPP of China was probably completed in 1958. This plant is relatively smaller with a capacity of 144 KW. In addition to this, a number of small TPPs are reported to have been constructed in China in 1958. In France, the Saint Malo pilot TPP, near the present Rance TPP, with a capacity of 9000 KW, was constructed in 1959. It is considered to be the first large pilot TPP in the world. The next and the most famous TPP at Rance was commissioned in 1966. The installation of its 24 turbines was completed in 1967. It gives 240,000 KW of power. This is the first tidal power plant in the world which is totally controlled and monitored by computers.

The other important TPP is the Russian experimental power station at Kislaya Guba in the Barents Sea. It was commissioned in 1968. In this plant, the power house was prefabricated, floated to the site and then sunk into a carefully prepared foundation. The capacity of this plant at present is only 440 KW. New TPPs are under consideration in a number of countries like U.K., France, U.S.A., Canada, Argentina and Russia.

Possibilities of TPPs in India

Like many other nations, India is also following a very conventional policy as far as her power resources are concerned. Our main commercial and non-commercial sources of energy are shown in Table 2. At present we are importing crude petroleum of the order of 14 million tonnes at the annual cost of Rs. 1,160 crores to meet our power requirements. Of our total production capacity of about 20,000 MW of electric power, the thermal plants give us 61%, hydroelectric projects 37%, and nuclear plants 2 %.



"His interest in tidal power is now ebbing out."

Table 2. Various sources of energy in India

Commercial	
1. Oil and natural gas	50%
2. Coal	29%
3. Electricity	21%*
Non-commercial	
Cow dung	50%
Firewood vegetable wastes alcohol	50%

*The 21% amounts to 20,000 MW of power which includes thermal, hydro-electric and nuclear in the ratio of 61 : 37 : 2

A preliminary study conducted by the National Institute of Oceanography, Goa, indicates that some areas in Gujarat are very promising for a large tidal power plant. In addition to Gujarat, several other areas can be considered for tidal power generation. For example, in Bombay, the average neap tidal range is about 1.4m and the total average tidal range 2.5 m. If a small bay of approximately 1 km^2 is enclosed for constructing a power plant, a generating capacity of 900 KW can be obtained (Fig. 6). With a 'single basin—two way scheme'

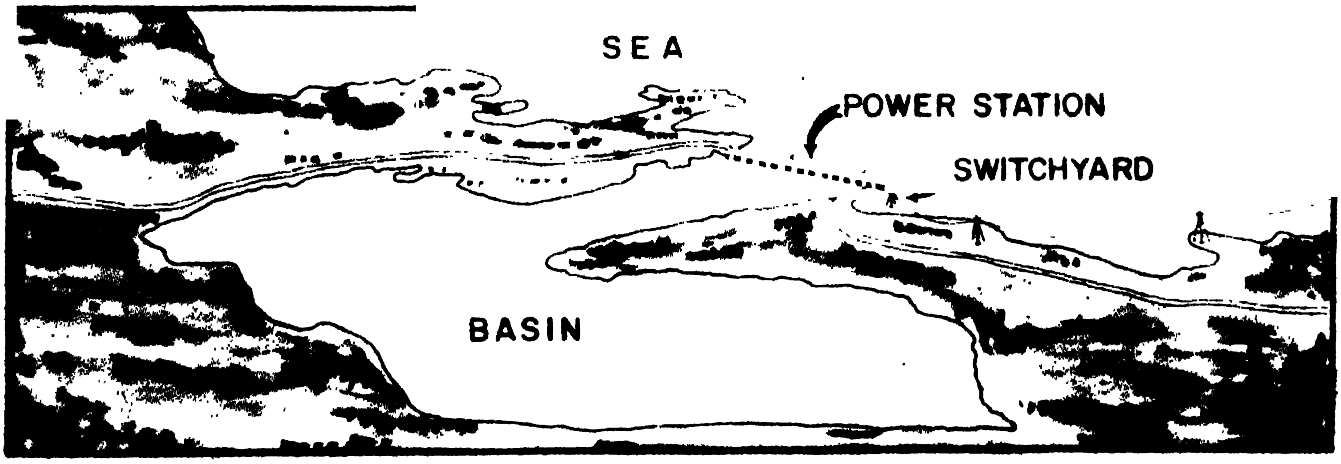


Fig. 6. A diagrammatic representation of a tidal power plant

it could possibly generate power in two steps for 17 hours in 24 hours, but no tidal power will be available for 7 hours. In Bhavanagar, if an area of 1 km^2 were to be enclosed to form a tidal basin where the average neap range is 4.8 m (total average range 6.8 m), a power plant of approximately 700 KW capacity could be developed. If we could dam the big bay in which the port Navalakhi is situated, with 1 km long power house, sluices and dykes at the Hansthal creeks, we can generate power of the order of 600 MW.

The survey conducted by the National Institute of Oceanography in the Gulf of Cambay and Kutch has indicated that the water in the Gulf of Kutch contains very little suspended material whereas in the Gulf of Cambay the water has a very high suspended load. Because of the possibility of silting in the tidal basin due to the settlement of suspended material, when water is stored, the Gulf of Kutch, inspite of its having a lower tidal range than the Gulf of Cambay, may prove to be a better area for TPP. A detailed study is required in some of the promising areas of our country on the potential and scope of tidal power generation.

As has been noted above, the most important use of TPP is to augment power supply from thermal, hydroelectric or atomic power plants to meet the additional power demands during the peak periods efficiently. It is well-known that thermal plants cannot be easily switched off without incurring heavy expenditure in restarting them. In India, the general practice is to switch off some plants during the period when the demand is low (off-peak period). However, the general outlook is changing and the plants are kept running all the time. Surplus power is used for pumping water to higher elevations to run hydel plants. This type of hydel plants are being planned in a number of states like Tamil Nadu, Gujarat, Andhra Pradesh, Bihar and Maharashtra. In Gujarat, a TPP could become an ideal substitute for hydel plants.

One of the recent developments connected with the tidal power generation in India is a report prepared by Prof. E. M. Wilson, who visited India for a period of two months as a tidal power expert of the United Nations Development Programme. He paid a brief visit to NIO also. In his excellent report submitted to the Government of India, he has identified 4 possible schemes of TPP in the Gulf of Cambay and 5 schemes in the Sunderbans area (West Bengal). He has recommended an approach to bring in "bluecoal "in India.

We feel that the projects suggested by Prof. Wilson are too large to be attempted at this stage. The Cambay-1 scheme of Prof. Wilson which can generate 4000 MW to 7400 MW of power would cost about Rs. 1,925 crores. What appears to be important for India is smaller schemes at the ideally located sites involving a minimum amount of expenditure.

Unfortunately our knowledge about the problems associated with tidal power development in India is limited at present. A detailed feasibility study on some of the basic problems such as the suitability of an area and the environmental changes associated with tidal power generation is urgently needed for our country.

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SCIENCE SPECTRUM (*Continued from page 526*)

Rauwolfia vegetation. A symposium was organised by medical and veterinary scientists on *Indigenous Drugs of India* at the 64th session of the Indian Science Congress at Bhubaneswar in 1977. The Botanical Survey of India is also taking keen interest in surveying this indigenous drug plant all over India.

her reading

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PAUL ADRIEN MAURICE DIRAC

The famed physicist will be 75 on August 8, 1977

PREM CHAND JAIN

THE fundamental conceptions of the 20th century physics have revolutionized modern thought and activity. Quantum theory, relativity, and the modern ideas on the structure of matter have contributed to a deeper understanding of Nature. They will probably rank in history among the greatest intellectual achievements of all time. Paul Adrien Maurice Dirac has been one of the chief architects of Quantum Theory. August, 8, 1977 marked the 75th birthday of this great English physicist, who can well be called the greatest living physicist and named in the same breath as Newton, Einstein, Bohr. It is worthwhile on this occasion, besides wishing the great physicist a long and fruitful life, to refresh the memory of his main achievements and to know about his life and way of looking at various developments in physics.

Main contributions

The most important contribution of Dirac, which represents one of the turning points in physics, came when he was only 25 years old. In 1928 Dirac developed an abstract mathematical theory to describe the properties of the electron. Given only the particle's charge and mass, he was able to derive the electron's spin, magnetic moment and other quantitative aspects of its behaviour. This equation was the first to account rigorously for the observed properties of the electron. One of its consequences was the prediction of a particle, then unknown, identical to electron but with positive electric charge. C. D. Anderson's discovery of positron in 1932 gave experimental confirmation of this consequence of Dirac's theory. It marks one of the most beautiful examples of how far human intellect can probe into the mysteries of the world by sheer logic

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and sense of judgement. For this accomplishment, Dirac shared with Ervin Schrödinger the 1933 Nobel Prize in physics.

In 1925 two young Dutch physicists, Samuel Goutsmit and George Uhlenbeck, in attempting to account for anomalies in X-ray spectra, suggested that every electron has a permanent spin : that it rotates about its own axis with an angular momentum of $\frac{1}{2}\hbar$. Although it disposed of the spectroscopic inconsistencies, the new model of the atom introduced difficulties of a theoretical nature, as nothing in the then current theory required the electron to spin. It thus became necessary to transform the spinning electron hypothesis from an ad-hoc assumption to a theoretically explainable fundamental of quantum theory.

First to attack the problem were Wolfgang Pauli and C. G. Darwin. Their efforts, however, suffered from a multiplicity of assumptions unjustified except for the need to introduce them into an equation describing the electron's spin. It therefore required the genius of Dirac to propose a new and more satisfactory approach.

'Dirac had not set out to account for the spin of the electron. He merely tried to improve on Schrödinger's equation by writing it in a form that would fit into Einstein's theory of relativity. Dirac is mainly a mathematician and his procedure was guided by the demands of mathematical consistency and elegance. In classical relativistic mechanics the energy equation of a particle was written as

$$E^2 - p^2c^2 - m^2c^4 = 0 \quad \ldots \quad (1)$$

where E is the total energy, p the momentum and m is the rest mass of the particle, and c is the velocity of light. From this the quantum mechanical wave equation was derived by replacing E and p by the operators $i\hbar\frac{\partial}{\partial t}$ and $-i\hbar\frac{\partial}{\partial r}$ and causing the left hand-side to operate on a wave function ψ. This gave rise to squared operators $\frac{\partial^2}{\partial t^2}$. Dirac's reasoning led him to regard this matter as being the crucial difficulty, as, in general, quantum mechanics required equations to be linear in $\frac{\partial}{\partial t}$ or E. He, therefore, sought to replace Eq. (1) with an equivalent one which would be linear in E and would thus contain only linear operator $\frac{\partial}{\partial t}$.

To do this, Dirac factored the left-hand side of Eq. (1) into two new equations, both linear in E. Either of these, when set equal to zero, became an energy equation of the sort required. Having shown that the two factors were equivalent, Dirac discarded one and was left with Eq. (2).

$$(E - c\alpha_k p_k - \alpha_0 mc^2)\,\psi = 0 \ \ldots \ (2)$$

Here, the α's were new variables operating on ψ which had initially been introduced in order to obtain a wave equation linear in E. Dirac realized that for constructing a relativistic wave equation, it was necessary to describe the wave function at each point by four numbers ('components'). Now, since the α's can be represented by 4-dimensional matrices involving only constants, Dirac concluded that they should refer to some inner property of the electron. He proceeded to show that the property involved was precisely the electron's spin.

Dirac then modified Eq. (2) so as to represent the energy of an electron in the presence of an electromagnetic field. The resultant equation gave the electron a magnetic moment of one Bohr magneton. It further stated that the orbital angular momentum was not sufficient to uphold the conservation of angular momentum of an electron moving in a central field. Dirac showed that the conservation of angular momentum was restored by supposing the electron to have an additional spin angular momentum of $\frac{1}{2}\hbar$. He went on to show how this equation accounted for the behaviour of the electron in hydrogen atom and the anomalous spectra which had first suggested the idea of a spinning electron. Other experimental verifications quickly followed.

However, Dirac's theory encountered a serious difficulty. The equation for the electron gave two possible kinds of solution : the states of positive energy as well as the states of negative energy. In Dirac's own words: "This seemed to be a stumbling block to begin with, but it turned out that one could get over that difficulty in a very neat way at the expense of changing one's concept of the vacuum".

The vacuum was thought to be a region where there was nothing at all. Dirac interpreted the vacuum as a state of lowest energy. Now if the electrons can have negative energies too, one would want to have as many of these electrons as possible in order to get the lowest energy. However, according to Pauli's exclusion principle, there cannot be more than one electron in a state. Therefore, the lowest energy state would be a state in which all the negative energy states but no positive energy states are filled. This was the new definition of vacuum given by Dirac.

Now if we have an electron with positive energy, it cannot jump into a negative energy state in vacuum as all the states are already filled. However, it is possible that a photon could excite an electron in the negative energy state in vacuum to one in the positive energy state, thus creating an electron-hole pair. Such a hole was later interpreted as positron. Dirac also predicted that the opposite reaction could occur:

An ordinary or positive energy electron may jump into the hole and fill it up. Then both the electron and the hole disappear. This is interpreted as electron and positron annihilating one another. Their energy will be emitted in the form of chargeless photons. Both these predictions, appearing little more than mere speculations at the time they were advanced, were directly confirmed by experiment not long afterwards.

Dirac's success set a new fashion in theoretical physics. His theory was much more elegant than the earlier mathematical garments which had been laboriously tailored to fit the experimental facts. Now it became fashion to frame a new, elegant mathematical garment and to ask the experimentalists to test its validity. That trend is particularly strong in the theory of fundamental particles.

In addition to the above most important work Dirac has made several other important contributions in quantum physics, particle physics and the theory of gravitation. Dirac introduced the bra and ket vector notation in quantum mechanics and developed the non-commutative algebra-- the algebra of the *q* numbers. So, while solving a quantum mechanical problem, one can equivalently deal in terms of the Schrödinger's wave functions, Heisenberg's matrics or Dirac's q number. Dirac's algebra is, however, found to be most useful and is widely used at present.

In 1937 Dirac put forth his famous hypothesis of large numbers. He took the mass of the electron, the radius of an electron's orbit in hydrogen atom and the time required by a photon to travel that distance as the fundamental units of mass, length and time respectively.

Using these fundamental units, Dirac calculated, besides the speed of light, the mass of the photon, etc., the age of the universe and the ratio of the electron field to the gravitational field between an electron and a proton. Surprisingly, the value of both came out to be $\sim 10^{39}$. Dirac did not take this as merely accidental but proclaimed this to be the discovery of a universal law, viz., the value of the gravitational field is reciprocal of the age of the universe. So, according to this theory, the value of the gravitational constant G is decreasing with time. He extended his assumption to assert that whenever we have an enormous number turning up in nature, it should be connected to the age of the universe. He then proceeded to calculate the total number of nucleons present in the universe which turns out to be nearly 10^{78}. This number is the square of the age of the universe at present. From this he concluded that the total number of nucleons present in the universe at any time is the square of the age of the universe at that time. This hypothesis implies the continuous creation of matter in the universe. This continuously created matter could be produced: (1) continuously throughout space, (2) locally in proportional to the amount and composition of matter already present, or (3) in special places such as the centres of galaxies, or some such-like thing. Of these, Dirac chose the second possibility.

Though it has not yet been possible to decide conclusively in favour or in disfavour of Dirac's hypothesis, it will have far-reaching implications in science if it holds true.

Another interesting contribution from Dirac came in 1948. He developed a general theory of particles with electric charges and magnetic poles in interaction with the electromagnetic field. The theory is symmetrical between charges and poles and as such predicted that separate poles could be observed. That one does not usually observe the separate poles like the separate charges was ascribed to the much larger attractive force which exists between two one-quantum poles of opposite sign as compared to the force between two one-quantum charges at the same distance. It must therefore be very difficult to separate poles of opposite sign. Owing to the very high binding energy of these particles, it was suggested that one should look for the particles with monopoles in atomic processes where energies of the order of 5×10^8 electron volts are involved. They should appear as heavily ionizing particles and would be distinguishable from ordinary charged particles by the property that the ionization they produce would not increase towards the end of their range but would roughly remain constant.

Following the prediction of the monopoles, numerous searches for them have been made. Some have even claimed to have discovered the monopole, while others have refuted this claim so that the question whether monopoles exist or not is still debatable.

Views on development of physics

According to Dirac the development of physics consists of a steady development superimposed by a number of big jumps. It is these big jumps which are actually the most interesting and important feature of this development. The background of steady development is largely logical. It takes place as a natural sequence from the previous setup by the application of the well-known fundamental principles. The big jumps are something entirely new. These big jumps usually consist in 'overcoming a prejudice'. By 'prejudice' Dirac means a conception which is there from time immemorial and is taken for granted. But then a physicist finds that the concept has to be questioned. He has to replace this 'prejudice' by something more precise and leading to some entirely new conception of nature.

The special relativity provides a beautiful example of this shedding of a 'prejudice'. It changed the concept of simultaneity. Earlier, scientists used to think it obvious that the statement that two events take place simultaneously has a precise meaning, an absolute sense. But it was left to Einstein who, in the light of accurate experimental evidence, really grasped the need for getting rid of this absolute concept of simultaneity and replacing it by a new four-dimensional picture of the world in which the space and time have to be considered on the same footing.

Quantum theory has developed through several big steps. Planck's introduction of finite quanta of energy in the electromagnetic field, Bohr's model of the atom and the final formulation of the quantum theory have all been big jumps and each represents the replacement of an old concept by an altogether new one. That how difficult it is to get rid of the deep-rooted old concepts and how these 'prejudices' block the path of further progress may be clear from the following candid assertion of Dirac:

"Up until about 1930 physicists thought there were only two fundamental particles, the electron and the proton. The reason for that was that there are two kinds of electricity, positive and negative, and a particle is needed for each of them, and that is all that one needs. There was very strong reluctance to postulate new particles up until about that time.

"That led me astray when I first worked out the ideas about the holes in the vacuum distribution of electrons. I felt that the holes must represent protons because they certainly had a positive charge. I thought right at the beginning I would expect them to be symmetrical with the electrons and to have the same mass as the electrons. But it was rather inconceiveable to me that there should be a new particle with a positive change and the mass of the electron. I reasoned that if such particles did exist, the experimentalists would certainly have seen them.

"Why did the experimentalists not see them? Because they were prejudiced against them. The experimentalists had been doing lots of experiments where particles were moving along curved tracks in a magnetic field. The curvature indicates which way the particle is moving along the track if one knows the sign of its charge. The experimentalists regularly saw electrons coming out from a source and having the appropriate curvature in the tracks. But they sometimes saw the opposite curvature, and interpreted the tracks as electrons which happened to be moving into the source, instead of the positively charged particles coming out. That was the general feeling. People were so prejudiced against new particles that they never examined the statistics of these particles entering the source to see that there were really too many of them.

"Since about 1930, the climate of opinion about new particles has changed completely. Many new particles have been discovered and experimenters and theoretical people are both willing to postulate new particles on the flimsiest grounds."

Though Dirac feels that the Quantum Theory is an extremely good theory and it is in wonderful agreement with observation over a wide range of phenomena, he does not feel complacent about the present state and is fully aware of its shortcomings too. How one can form a consistent picture behind the rules for the present quantum theory is one kind of difficulty. Another difficulty of this theory is that when one applies these laws to extreme conditions–to phenomena involving high energies or smaller distances—one sometimes gets results that are ambiguous or not really sensible at all. Of these, he does not attach much significance to the first difficulty which is of conceptual nature. He regards that the developments of the physicist's conception of nature is continuously evolving and at present we are nearly in an interim stage. We must not attach too much importance to the present concepts as we must expect future developments of fundamental character which will change these concepts.

Dirac believes that it is more important to have beauty in one's equations than to have them fit experiment. A search for beauty together with a real, sound insight is a sure line of progress. If there is no complete agreement between the results of one's work and experiment, one need not feel discouraged, as the discrepancy may be due to minor features that are not properly taken into account and that will get cleared up with further developments of the theory.

Life and awards

In seeking to understand the achievements of this great physicist one might well wonder the role played by chance. Dirac would have, under normal conditions, pursued a career in electrical engineering, a field in which he graduated from Bristol in 1921. On graduation he looked for a job but could not get one because of the depression in that field. He went back to Bristol and decided to study mathematics. Dirac and Miss Dent were the only two students in the honours course in mathematics. Miss Dent was quite determined to take a course in applied mathematics. In order that the mathematical faculty does not have to give two sets of courses, Dirac also chose applied mathematics. That was his way back to science from where he never looked

(Continued on page 483)

THE WORLD OF PRIMES

The prime numbers are like stars in the galaxy to be looked at with ever increasing curiosity and wonder

SHYAMAL K. MAJUMDAR

FOR a long time now, both professionals and amateurs in number theory have shown great interest in the sequence of integers 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31... known as prime numbers. The basic characteristic of these numbers is that they have no divisors except unity and themselves. Although it is not possible to say exactly when the concept of prime number was first clearly defined, some elementary facts about them were known to the ancient mathematicians. For example, in the works of the Greek geometer Euclid (300 B.C.) we find the following theorems about the prime number :

(i) Every positive integer can be expressed as a product of primes. The factorisation is unique except for a rearrangement of the factors; (ii) The number of primes is infinite; and (iii) The primes can be listed by the 'Sieve of Eratosthenes'.

An elementary proof of (ii) based on Euclid is as follows : Suppose there exists a largest prime number p. Take the product of the primes $2, 3, 5, 7 \ldots p$ and call this number. N. Consider the number $N + 1$. This number is obviously greater than p. Also, no prime from the set $2, 3, \ldots$ p divides $N + 1$ as they all leave the remainder unity. So, either $(N + 1)$ is itself a prime or by (i) $N + 1$ has a prime factor larger than p. Both conclusions contradict the hypothesis of p being the largest prime.

Eratosthenes (276-194 B.C.) was another Greek scholar who developed a procedure for sorting out the primes. Suppose we want to list all the primes less than 100. We first write out all the numbers from 1 to 100. Starting from 2, we strike out from the list every second number which is a multiple of 2, i.e., 4, 6, 8, 10,....till 100. Next we discard from 3 every third number which is a multiple of 3, i.e., 6, 9, 12,...., etc. Then start from 5 and discard every fifth number, i.e., 10, 15, 20...., etc. Obviously, numbers like

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6, 12, 15, will occur more than once in the discarded list. This repetition is partially reduced by using the fact that for primes upto N, we need to erase all multiples of the primes 2, 3, 5, 7,.... which are less than $\sqrt{N}$. For example, if $N=100$, we need not strike out multiples of 11 ($11 > \sqrt{100}$) since prime multiples of 11, e.g., 22, 33, 55, 77, 99 have already been discarded earlier. An algorithm based on this idea and suitable for use on a modern computer for finding primes below N is given below :

1. Store 3 as the first prime number and as N.
2. Add 2 to N.
3. Start dividing N by the primes found earlier.
4. If the remainder is zero for any of the division then N is not a prime number. Go to step 2.
5. If the square root of the prime number which was the last divisor exceeds N, then N is itself a prime number. Store it in prime number list.
6. If $N < 10^6$ (say), go to step 2.
7. Print the prime number list.

Note that the even prime 2 must be added to the final list to make it complete. The set of primes between 1 and 209 are given in Table 1.

The number 2 is the only even prime, the rest are all odd. A number that is not prime is called composite. Tables giving the prime factors of composite numbers are often useful. A factor table gives the least prime divisor of a composite number. Since it is not difficult to find out whether a number is divisible by 2, 3, 5, the numbers divisible by them are often excluded from the factor tables so as to economise on the size of the table. One of the most authentic factor tables of numbers upto ten million is the work of D. N. Lehmer (1867-1938) of U. S. A.

Table 1

Primes below 100	Primes between 100 and 200
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97	101, 103, 107, 109, 113, 127, 131, 137, 139, 149, 151, 157, 163, 167, 173, 179, 181, 191, 193, 197, 199

How are the prime factors of a composite number determined? One of the early attempts in this direction was made by the French mathematician and jurist P. de Fermat (1601-1665). An odd composite number is expressed as the difference between two squares which is easily factorised. The pair of numbers in these factors are then determined by an iterative method. Let n be an odd composite number and suppose

$$n=ab,\ b \geqslant n \qquad ...(1)$$

We want to write n as

$$n=x^2-y^2=(x-y)\ (x+y) \qquad ...(2)$$

which means

$$a=x-y \text{ and } b=x+y.$$

It follows that

$$x=\frac{b+a}{2},\ y=\frac{b-a}{2} \qquad ...(3)$$

Now as n is odd, both x and y are odd integers. From (2) we can write

$$x^2=n+y^2 \qquad ...(4)$$

We see from (4) that $x^2 \geqslant n$ and so $x \geqslant \sqrt{n}$. We now successively substitute on left hand side of (4) values of x greater than $\sqrt{n}$ and check whether the corresponding x^2-n is a perfect square. Through his factorisation technique, Fermat was able to decompose a large number of odd composite numbers into their prime constituents. For example, Fermat found that the factors of 2, 027, 651, 281 are 46, 061 and 44, 021 each of which is a prime. The chain of computation in this factorisation procedure is actually not very lengthy because in most cases the last two digits of x^2-n tell us whether it is a perfect square or not. We know that the last two digits of a square number are confined to the following 22 possibilities :

00
01
04
09
16
21
24
25
29
36
41
44
49
56
61
64
69
76
81
84
89
96

Fermat, one of the greatest number theorists, derived a few important theorems on primes and made some interesting conjectures (incidentally, number theory is a fertile field for conjucture making!) about the primality of numbers of certain types. Fermat conjectured that all numbers of the form $2^{2^n}+1$ are primes. These numbers are known as Fermat numbers F_n. It is easy to verify that for $n=0$, 1, 2, 3, 4, the corresponding Fermat numbers 3, 5, 17, 257 and 65, 537 are all primes. Fermat's conjecture was proved to be false by the Swiss mathematician L. Euler (1707-178A.D.) who discovered that

$$F_5=2^{2^5}+1=4294967297$$
$$=641 \times 6700417$$

is a composite number. Euler also developed a factorisation method which applies to numbers which can be represented as the sum of two squares. He also proved a theorem of Fermat that every prime of the form $4x+1$ can be represented as the sum of two squares. For instance, when $x=1$, 3, 4,............we get primes of the form 5, 13, 17............, and they can be expressed as the sum of two squares, e.g., $5=2^2+1^2$,

$13=3^2+2^2,\ 17=4^2+1^2$

Fermat proved that for every number '*a*' not divisible by the prime p, $(a^{p-1}-1)$ is eactly divisible by p. Euler generalised this theorem of Fermat by proving that if the positive integers a and m are prime to each other then $(a^{\phi(m)}-1)$ is exactly divisible by m where $\phi(m)$ is the number of integers from 1 to m that do not divide m exactly. For example, when $m=9$, $\phi(9)=6$. If $m=p$ and p does not divide a, we get Fermat's theorem.

M. Mersenne (1588-1648 A.D.) was a Franciscan friar and a contemporary of Fermat. Mersenne was interested in numbers and in a list prepared by him in 1644 he conjectured that numbers of the form 2^p-1 were primes, where p itself was a prime $\leqslant 257$. Numbers of the form 2^p-1, where p is a prime, are known as Mersenne numbers M_p. Like Fermat numbers, all Mersenne numbers are not primes. In fact, several errors were detected in the list of Mersenne in late nineteen forties. Table 2 taken from a recent article by John Brillhart, D. H. Lehmer and J. L. Selfridge (*Mathematics of Computation* Vol. 29, No. 129, 1975), gives the recent status of some of the Mersenne numbers M_p.

Table 2

p	Character of 2^p-1
2, 3, 5, 7, 13, 17, 19, 31, 61, 89, 107, 127	Prime
(All other $p < 172$) and 179, 181, 197, 233, 239, 241	Composite and completely factored
199, 227, 257	Composite but no factor known

The first twelve Mersenne primes appearing in the first row of Table 2 were known long before the appearance and use of computers in research. For example, M_{31} was found by Euler in 1750. From early nineteen fifties, computers have been giving impetus to research in different branches of number theory. Computer-aided researches are directed towards (1) searching for new primes; (2) factorising numbers having special forms into prime components; (3) verifying or demolishing outstanding conjectures; and (4) studying twin primes.

Pioneering researches relating to problems (1) to (4) have been carried out by D. H. Lehmer (b. 1905), his wife Emma Lehmer and their associates at the University of California, Berkeley, U. S. A. Over the past forty years they have developed a variety of factorising methods and tests for identifying a prime, e.g., the electronic sieving machines that carry out the factorisation process automatically and accurately at a very high speed.

The primality of M_p for $p=521$, 607, 1279, 2203 and 2281 was announced by this group in early nineteen fifties. Later, it has been established that M_p for $p=3217$, 4253, 4423, 9689, 9941 and 11213 are primes, the last three being discovered by D.B. Gillies. The 23rd Mersenne prime $2^{11213}-1$ was found by Gillies in 1963-64 on the computer at the University of Illinois, U. S. A. and was the largest known prime till 1971. The people of Illinois were so happy at this discovery that they arranged for the US Post Office to cancel the stamps on locally posted letters with the statement "$2^{11213}-1$ is a prime." The 24th Mersenne prime, $2^{19,937}-1$ was found by Bryant Tukerman using an IBM 360/91 computer at the IBM Research Centre at Yorktown, New York, on the evening of March 4, 1971. This is the latest and largest known prime number having 6002 digits beginning and ending with 4315424............8041471.

The concept of perfect numbers owes its origin to the Greek number theorist Pyhthagoras (582-507 B.C.) and his associates. Perfect numbers are closely related to Mersenne primes. An integer n is called perfect if it equals the sum of its divisors. The numbers 6 and 28 are elementary examples ($6=1+2+3$ and $28=1+2+4+7+14$). An even integer is perfect only when $n=(2^p-1)2^{p-1}$ for some prime p for which 2^p-1 is a Mersenne prime. The largest prime found so far is M_{19937} and the 24th even perfect

"*Although he lives in his world of primes, he has not given me the feeling that I have a secondary place in it.*"

number is $(2^{19937}-1).2^{19936}$. This is the largest perfect number so far. This number has 12,003 digits and begins and ends with 931144.... 942656. These results were found by Bryant Tuckerman in 1971.

Factorisation of Fermat numbers and numbers having specified forms such as $2^n \pm 1$, $2^{2n} \pm 2^n + 1$, etc., have been attempted by D. H. Lehmer and his associates at California University. The seventh Fermat number $2^{2^7}+1$ was decomposed into to its prime constituents on the IBM 360/91 machine by Michael A. Morrison and John Brillhart on the morning of September 13, 1970. The number has 39 digits and had previously withstood many attempts at its factorisation. One of its prime factors is 59649589127497217. We know that the number of primes is infinite but how are they distributed among the total set of integers ? The distance between the successive primes is irregular and appears to increases as we move higher up in the sequence of integers. Let x denote any positive number and $\pi(x)$ the number of primes within and including x (e.g., if $x = 10$, then $\pi(x) = 4$). The Prime Number Theorem (PNT) asserts that as x is made arbitrarily large, the difference between $\pi(x)$ and $x/\log x_e$ falls off as higher powers of $x/\log x_e$. The French mathematician J. Hadamard (b. 1865, died recently) and the Belgian de la Vallee Poussin (b. 1866) independently gave the first complete proofs of the PNT in the year 1896.

Two famous conjectures, one on primes and another on perfect numbers, that are yet to be proved or disproved are worth mentioning. The first one was proposed by the German mathematician and civil servant C. Goldbach (1690-1764 and is known as Goldbach's conjecture. Goldbach speculated in 1742 that every even integer $\geqslant 6$ is the sum of two odd primes and every odd integer $\geqslant 9$ is a sum of three primes. The Russian number theorist Vinogradov proved in 1937 that every sufficiently large odd number is a sum of three primes, but this result is in no way a proof of the conjecture. Vinogradov received the first prize of 100,000 roubles for his work on Goldbach's problem. The second conjecture relates to the odd perfect numbers. Do there exist any odd perfect numbers? Nobody has been able to prove or disprove their existence! Recently (1968) B. Tuckerman announced that an odd perfect number, if it exists, must have at least 36 digits.

The phenomenon of twin primes poses questions regarding their distribution and pattern formation similar to those arising in the case of primes. The least possible distance between two consecutive primes (excepting 2 and 3) is 2. The prime pairs separated from one another by an even multiple of 2 are known as twin primes. The twin primes under 100 with separation distance 2 are (3, 5), (5, 7), (11, 13), (17, 19), (29, 31), (41, 43), (59, 61), and (71, 73). In the general case, a prime p and its escort p' is at a distance d where $p' = p+d$. A list of primes under 100 with $d = 6$ are (5, 11), (7, 13), (11, 17), (13, 19), (17, 23), (23, 29), (31, 37), (37, 43), (41, 47), (47,53), (61, 67), (67, 73) (73, 79), (83, 89), (97,103). This pair is more numerous than the previous pair ($d = 2$). It has been observed that under thirty million there are 152892 prime twins with $d = 2$, but nearly twice as many, viz., 304867 prime twins with $d = 6$. The density of prime twins with $d=2$, 4, 6, 8,....70 has been investigated by D. H. Lehmer and E. Lehmer. It seems that twin primes become quite rare in the tables as x is made larger and larger.

This brief survey of the prime numbers, highlighting some of the recent attempts and achievements in unveiling their secrets, is likely to create the impression that the world of primes is a strange world about which we perhaps know more than what we understand. This view is not altogether wrong. The primes are really like the stars in the galaxy to be looked at with ever increasing curiosity and wonder.

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THE SEARCH FOR EXTRA TERRESTRIAL LIFE

S.N. SINHA
J.J. GHOSH

The Viking mission has failed to find any sign of life on Mars. Does it mean we are alone in the universe?

EVER since man started understanding the scientific basis of the origin of life and the evolutionary processes on earth, he had been asking himself : Is earth the only place in the universe where life evolved ? What are the factors that control the origin of life in a heavenly body ? Is it that life evolves by chance or out of necessity when the starting materials are present ? With these questions in mind, man started searching life in his own solar system with the hope that a second finding of carbon-based life in the same solar system. would support the notion that life is indeed a property of carbon atom. Of all the elements, carbon and silicon happen to share the infinite capacity to combine with other elements to form large molecules. Although we have seen the unity among diversity of the carbon-based life in our planet, we have not yet come across any silicon-based life.

The search for extraterrestrial life depends upon a complete analysis of environment and soil of the planet which in turn calls for a meticulous experimental design free, as much as possible, from geochauvinism (we are all bound by our understanding of earth life, which may not be the case for the planet under study). In addition to this, a balanced advancement of a number of inter-disciplinary subjects are required. Fortunately, the last twenty-five years have seen tremendous developments in space science. The technology has reached such perfection as to undertake space missions for distant planets and to land fully automated and miniaturised laboratory for conducting physical, chemical and biological analyses of soil samples of remote planets. The present article will deal only with the biolo-

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gical analysis of soil samples which are used as markers for searching extraterrestrial life.

Soil as the marker for life

Since the life detection device makes its first impact on the surface crust of other planets, it is the soil where the search for extraterrestrial life seems pragmatic. Apart from this, it is known that soil is the repository and source of the widest diversity and the greatest density of microbial life. As we know, soil as an environment for microorganisms possesses certain unique features, which, although probably do not change the genetic and biochemical potentials of microorganisms, probably influence their phenotypic expression. Soil microbiology happens to share several points of relevance with the search of life on other planets. Search for primitive types of microbial life in the soil of other planets is, however, based on certain chemical assumptions, e.g., carbon is the most likely element on which extraterrestrial life would be based; that all biochemical reactions probably take place in aqueous solution; that the energy to sustain life is derived from sun through photosynthesis

In the first step, proper sampling of extraterrestrial soil becomes imperative. The samples are to be taken from an area unaffected by the landing of spacecraft. Stringent precautions are taken to avoid contamination of extraterrestrial soil with terrestrial microorganisms.

Life detection techniques: Methodology

Once an extraterrestrial sample is obtained, it is subjected to life detection experiments. The general experiments for the detection of extraterrestrial life are listed below:

Physiological studies

(a) Morphological evidence,
(b) Evidence of growth, and
(c) Evidence of reproduction.

Chemical and biochemical studies

(a) Evidence of metabolism,
(b) Evidence of photosynthesis, and
(c) Presence of organic compounds of biological interest by—(i) physical, (ii) chemical and (iii) biochemical assays.

The outlines of the experiments encompassing only metabolism, growth and reproduction are described below.

Metabolic studies. For the evidence of metabolism the instrument developed is known as "Gulliver", which essentially contains an incubation chamber. radioactive substrates, a gas trapping device and a Geiger counter (for measuring radioactivity). Radioactive substrates containing ^{14}C and ^{35}S in aqueous solution are injected into the soil sample. If microorganisms are present in the extraterrestrial soil, they will metabolise the radioactive substrates and produce radioactive gases. These radioactive gases are then collected by chemical precipitation and the precipitate thus obtained is measured for the presence of radioactivity by a radiation counter. An exponential increase in radioactivity is indicative of the existence of life with growth or reproduction. A suitable control is run simultaneously with the same soil sample in order to distinguish between a metabolic response and an inorganic reaction with the extraterrestrial sample. Inhibition is induced in the soil of the control unit by application of heat (sterilization) or by a chemical antimetabolite (inhibitors of metabolic pathways). "Gulliver" has undergone a number of modifications from time to time and its general applicability has rigorously been evaluated with terrestrial microorganism.

Experiments on photosynthesis. It is assumed that any extraterrestrial life will obtain its ultimate energy from sun. In order to validate this hypothesis, test for photosynthesis in the exotic environment becomes essential. To carry out the test for photosynthesis, a small quantity of the soil and its overlying atmosphere are enclosed. Radioactive carbon dioxide is then introduced into the trapped atmosphere in presence of light and time is allowed for any photosynthetic organisms present in the soil to fix carbon dioxide including the radioactive carbon dioxide. The enclosed atmosphere is then replaced by a fresh extraterrestrial atmosphere and light is excluded. The evolution of radioactive carbon dioxide takes place due to endogenous respiration of the photosynthetic microorganisms. The radioactive cabon dioxide thus produced is monitored by a process similar to "Gulliver".

Detection of adenosine triphosphate (ATP). The intermediate energy-rich adenosine triphosphate (ATP) is known to be present in every living terrestrial cell. A sensitive assay for ATP employs the luciferase enzyme system present in the lantern of firefly. This assay system is therefore employed to detect ATP in the exotic soil with the hope that existence of such an energy-rich compound would ratify the presence of extraterrestrial life. A sample of the soil is so treated as to release the microbial ATP, for example, by extraction with dimethylsulfoxide. An aliquot of this extract is then injected into a solution containing the luciferase system extracted from the firefly lantern (luciferase, luciferin, and magnesium ion in the presence of dissolved oxygen). Presence of ATP will result in the appearance of light. The peak intensity of light produced is directly proportional to the amount of ATP present. The reaction is monitored in an instrument containing a photomultiplier tube and the result is displayed on an oscilloscope

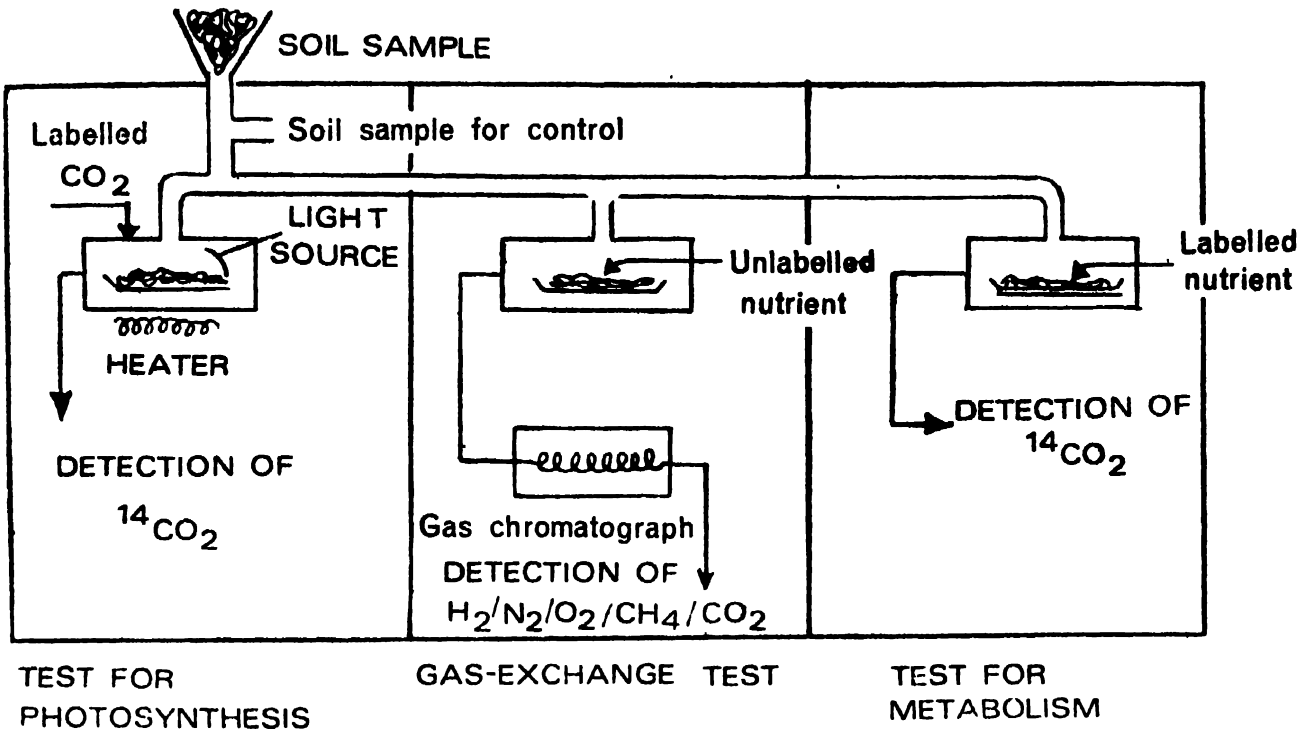

Fig 1. Biological analysis of the Martain soil sample

or recorded in a strip chart. The miniature model of ATP assay instrument can extract ATP from particulates and conduct quadruplicate assays within two minutes. Although this assay is fairly sensitive, the mere presence of ATP however cannot establish the existence of life. The reason is that under primitive earth conditions, ATP was presumably synthesized abiogenically (non-biologically). Nevertheless, indication of an increase in ATP content with time in a soil sample can be regarded as a firm evidence for the existence of life.

Phosphate uptake experiment. Requirement for inorganic orthophosphate for the synthesis of ATP and nucleic acids is a well-known phenomenon in terrestrial biochemistry. Therefore, the uptake of orthophosphate from solution can be regarded as a further evidence of metabolism in extraterrestrial soil. Radioactive phosphorus is not used due to its short half-life. Orthophosphate solution is incubated with the soil, and at intervals aliquots are removed and filtered. They are then assayed for the disappearance of dissolved orthophosphate by stannous chloride—ammonium molybdate method. Uptake of orthophosphate can take place even in the absence of growth or reproduction. Therefore a control is also run along with the experimental test. The antimetabolite used in the control is 2, 4-dinitrophenol which is a well-known uncoupler of oxidative phosphorylation.

Automated microbial metabolism laboratory (AMML)

It was realized as early as 1965 by NASA and the biological community that a successful planetary exploration programme requires the integration of a number of individual biochemical experiments into a single instrument package. This package would constitute an automated laboratory to be landed on the surface of the planet. AMML has been developed by Dr. Gilbert V. Levin and his group of Biospherics Research Inc., Washington, D.C. and was supported by the Bioscience Programmes, Office of Space Science Applications, NASA.

Six metabolic experiments and six associated physical determinations of biological interest are incorporated into the AMML. The physical measurements serve two purposes. They are useful for interpretation of the biological results and, with relatively minor modifications, give an idea of the environment. Specifically, the parameters to be studied are temperature, atmospheric oxygen, pH of soil, light intensity, background radiation and soluble phosphate content of the soil. The metabolic experiments have been mentioned earlier.

The results from all the metabolic experiments are to be translated into a common energy form. This is done by converting all metabolic readouts (results) to light pulses so that they can utilize a common sensor system, e.g., a photomultiplier tube circuit. The radioisotope experiments would use scintillators to convert the beta particles into photons, i.e., conversion of radiation energy to light energy. The output of the ATP assay experiment is already in the form of light. Phosphate is quantitatively precipitated by a radioactive compound and the radioactivity in the precipitate is converted into light pulses by scintillators.

Is our red planet alive ?

With this background of the principles encompassing the extraterrestrial life detection experiments, let us now discuss the biochemical experiments that have been immaculately performed by the "Viking landers" to search life on Mars. Since the exact experimental details, the observations and inferences thereof are beyond the scope of the present write-up, only a general description of the experiment will be attempted. The Viking mission was set to perform the first extraterrestrial biological experiments and is therefore looked upon as a landmark in the history of exobiology. Three separate biological experiments packed into a miniaturised laboratory which measured only one cubic foot was developed at a cost of 50 million dollars. The three biological experiments in Viking's package laboratory were for (a) Photosynthetic analysis, (b) Metabolic analysis, and (c) Gas exchange analysis. These experiments were based on different fundamental assumptions of Martian life, thus casting the investigative net as wide as possible taking into consideration the severe limitations on space and payload on the lander. The first two experiments were dependent on the assumption of carbon-based life but the third experiment was based on no such assumption.

Let us now have a look at the sequence of events that occurred after the Viking landed on the Martian soil. Shortly after touching down, the lander extended its telescopic sampling arm to scoop up about 130 cu. cm. of soil. Of this only 7 cu. cm was shunted towards the biology box. The first experiment that went into action was the pyrolytic release test for the detection of photosynthesis. A sample of soil was warmed in an incubation chamber and was then exposed for five days to radioactive carbon dioxide under the glare of an artificial sun (a Xenon arc lamp). The assumption was that as this gas is common in the Martian atmosphere it is likely to be exploited by organisms, and that these organisms harness the energy of the sun, just as plants and other photosynthetic organism do on earth. After the incubation was over, the gas was driven off and the sample was heated to 700° C to breakdown any organic compounds that were formed by photosynthesis, releasing radioactive carbon dioxide, which was monitored as described previously.

The next experiment that went into action, one day after the pyrolysis experiment, was the gas exchange test which was designed to determine whether carbon dioxide, nitrogen, methane, hydrogen or oxygen can take part in some kind of dynamic interaction with a sample of incubated soil. During a 10-day incubation period the gas composition was determined five times with a highly sensitive and miniaturised gas chromatograph. This experiment was done either with moistened soil or with soil bathed in a nutrient broth (an aqeous mixture of 19 amino acids, vitamins, a number of other organic compounds, and a few inorganic salts). The first experimental protocol presumed Martian organisms simply to be deprived of water, whereas the second was designed to look for organisms that may be lying dormant through a long absence of earthlike organic chemicals. In either case, a change in the composition of gas mixture would have been indicative of the existence of life on the red planet.

The last experimental system was for metabolic studies. This experiment was so designed as to see whether a mixture of basic biochemicals is metabolised in a Martian-like atmosphere during an incubation period of 11 days. Since the mixture of nutrients (formate, glycine, lactate, alanine and glycolic acid) were radioactive, utilization of these nutrients by organisms would release radioactive carbon dioxide. Controls for all the three experiments were run simultaneously with heat-sterilised soil (Fig. 1).

(*Continued on page 511*)

"There is a bit of self-contradiction in him. In lab, he is excited to his search for life outside the earth, but at home, he says life outside the earth could not be worse than the one on the earth."

THE FASCINATING AMPHIBIANS

Amphibians were the first vertebrates to conquer land. They gave rise to reptiles, birds and mammals

P. MOHANTY-HEJMADI

AMPHIBIANS represent the smallest group of vertebrates. There are approximately 3000 species of amphibians found on every continent except Antartica. The greatest variety occurs in the tropical jungles of the old and new worlds. Frogs and toads are never found in the sea. A small amount of the sea water is fatal to most developing tadpoles and an adult will die in a few minutes if immerged in sea water. Their vertical distribution is rather impressive, ranging from a few feet underground upto 450 meters (1500 feet) high up in the Andes and the Himalayas.

Of other major zoological classes, amphibians are least harmful to man. None of them has a poisonous bite, they do not rob us of our grains or fruits and they do not inflict any major disease upon us.

Amphibians are interesting animals. The first vertebrates to conquer land, they ultimately gave rise to reptiles, birds and mammals. Modern amphibians are divided into three groups : the caecilians or the limbless snake-like amphibians, the urodeles or the lizard-like salamanders and newts, and the anurans or the frogs and toads. In India there are 15 species of Caecilians, only one species of newt (*S. R.*, August, 1976), and a considerable number of anurans.

Importance

Frogs have done much to help man in his educational and scientific activities. They are easy to get, and their different systems like the alimentary, circulatory, nervous, and reproductive, can be traced with little effort. Amphibians are indispensable for biological and medical research. They can be maintained in confinement with little effort.

Much of our knowledge of limb regeneration is based on the studies of the larval and metamorphosing frog. A metamorphosing froglet which loses a limb can regenerate it but a fully formed adult cannot replace the lost limb. The fundamental work on transplantation was also done on amphibians. It was an exposed nerve in the leg of a dead frog which led to the experiments on transmission of electric current by the Italian physiologist Galvani. Frogs are used to diagnose "pregnancy" in women. In this test the urine of a woman is injected into a male frog; the

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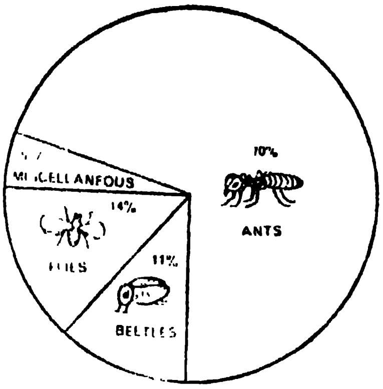

Fig. 1. Diet of *Bufo melanostictus* (reconstructed from Behura *et al.*)

pregnancy related hormones cause the extrusion of sperms within hours.

Parotid glands of toads located behind the eyes emit an irritating poison, when a toad is frightened or injured. Small amounts of the same poison are secreted by glands all over the skin. Predators that have tried to swallow a toad once never make the mistake again because the poison causes a burning sensation in the mucous lining of the captor's mouth and, therefore, eject out the prey. This poison has been used by ancient Chinese physicians for treating heart ailments. Chemical analysis shows that the poison contains digitalis-like substances which have been used for treatment of heart disease by European and American physicians. The toxins in the skin of poison arrow frogs (*Dendrobates* and relatives) have long been used by Indians of Central and South America for tipping their darts and arrows. They collect the poison by baking the frog over a fire. The heat forces the poison through the skin which collects like drops of sweat. These drops are collected into a jar. The most deadly poison can be extracted from Colombia's "Kokoi frog", which is only 2.5 cm long. The poison in small doses has medicinal value. It blocks transmission of impulses from nerves to muscles. and is an important chemical for research in neurology.

A frog or toad is truly a farmer's friend, for it consumes an enormous number of insects including injurious beetles. This has been known to sugar planters, who have imported giant South American toad *Bufo marinus* to save sugar plantations. In Puerto Rico, Haiti, Guam, Hawaii and other places, it protects a crop worth more than a billion dollars a year from sugar beetles. Its economic value is much greater in insect-ridden tropical countries like ours. A study of the stomach contents of 144 toads, *Bufo melanostictus* in Cuttack revealed 2736 insects, *i.e.*, 190 insects per toad. These toads had eaten many types of insects including whole cockroaches. An analysis revealed that they eat a considerable number of common pests like ants, flies and beetles (Fig. 1).

Froglegs are eaten in many parts of the world. In general the edible frogs, the North American bull-frog *Rana catesbeiana*, the European *Rana esculenta*, the Indian bullfrog, *Rana tigerina* and the Indian green frog *Rana hexadactyla*, are larger than common frogs. The Indian bull-frog can reach a length of 195 cm (6.5 inches). Valuable foreign exchange is earned by the export of froglegs to Western Countries. *Rana tigerina* is also eaten in some parts of Orissa. Unfortunately unlimited killing has led to the depletion of natural populations in some areas. Needless to say this has affected the ecosystem and has led to an increase in pests like paddy crabs.

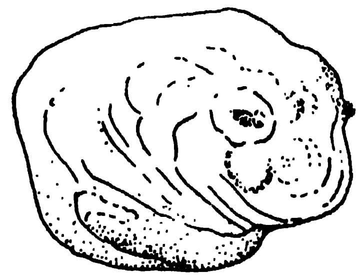

Fig. 2. Cocoon of *Ceratophrys*

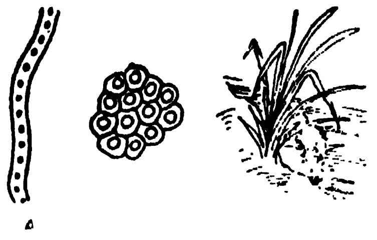

Fig. 3. Representative types of egg clusters *A. Bufo melanostictus;* ***B. Rana cyanophlyctis;*** *C Rhacophorus macultus*

Last but not the least, many people make a living by catching and supplying frogs to educational and research institutions.

Folklore

Almost every country has its folklore on frogs and toads. In Medieval Europe, frogs and toads were added to the witches' brew to cure all ailments. Priests used frogs and toads in ceremonies. Amphibian motifs are often found on pottery and baskets.

In Indian mythology, frog being a myridion of Indra the God of rain, plays a dominant role in rain making ceremonies. In parts of South India, two boys put a frog into a basket with some neem (margosa) leaves. They tie the basket to the middle of a stick. Supporting this stick on their shoulders, they visit every house in the village singing glories of Indra. It is believed that the louder the noise the captor makes, the better will be the rainfall! In Assam, frogs are wedded in an elaboratecere mony. Apparently this special treatment of the myridion pleases the God of rain. A rather cruel ritual is held in Bihar

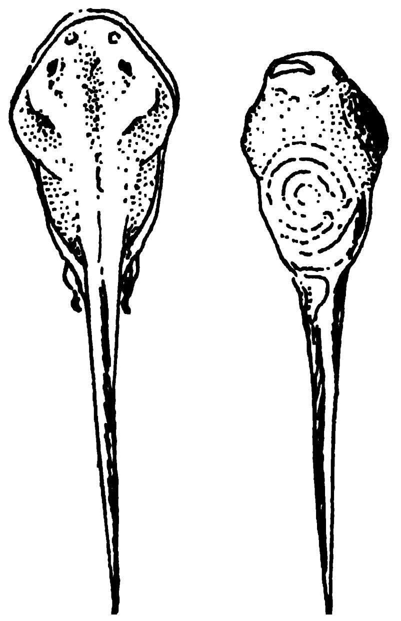

Fig. 4. *Bufo melanostictus* **tadpole (dorsal and ventral view)**

in which frogs are mercilessly tortured in order to draw the attention of Indra who sends rain just to save other frogs from such treatment. In Indian music the note "dhaibata" is named after the sound that the frog makes. In parts of Malaya the bright-coloured tree frog *Rhacophorus dennysi* is venerated by a religious cult, and on holy days one of these frogs is carried in a procession in its own 'sacred' throne.

The myth that toads can give "warts" is baseless. Reports about salamanders originating from fire is simply due to the fact that these amphibians live in hollow logs which are sometimes taken to the fire place. The heat of the fire drives them out. The stories of "rain of frogs" is true. The U.S. Weather Bureau has verified the fact that occasionally contents of a pool along with the frogs and fishes are scooped out by tornadoes and they are deposited some distance away.

Mark Twain has immortalized the extraordinary leaps of some frogs in his famous story. *The Celebrated Jumping Frog of Calaveras County*. An annual jumping contest is held in Calaveras which attracts the townspeople and tourists alike. The current record is held by "Maggie", an American bullfrog which jumped 5 metres (16 ft. 4 in.) in three consecutive leaps. In 1954, the winner, African *Rana oxyrhyncha*, leaped nearly forty-five times its own length in the 'Frogolympics' contest held at at Capetown.

Habits and life history

Amphibians are largely secretive, living under water or hidden in damp places. They cannot regulate their body temperature to any great degree and are mostly nocturnal because nights are cool and humid. Most hibernate during cold winter months. During hot dryer months, some aestivate. In extreme cases, like in *Ceratopprys*, a water conserving cocoon is secreted by the skin gland (Fig. 2).

Although a few of them, like the skipper frog *Rana cyanophlyctis* and the common toad *Bufo melanostictus*, are seen and heard throughout the year, most of them are seen and heard only during breeding season. In Europe and America, breeding takes place in spring and in tropical countries during the monsoons. Apparently, they lead a solitary life. They use a variety of references including odours, land-marks and celestial cues to reach the breeding pond which may involve covering a few kilometres. Their ability to find water is phenomenal. In my laboratory a large container with water is kept in a corner and all the frogs and toads which escape are found in or near the container within a few hours.

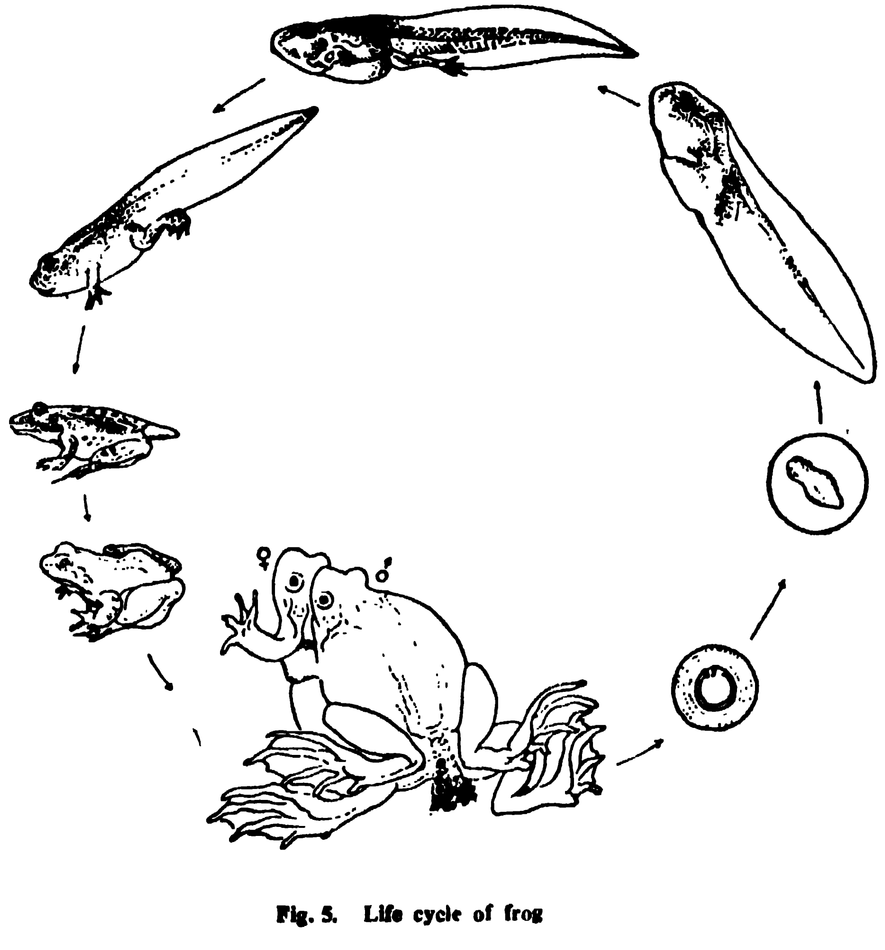

Fig. 5. Life cycle of frog

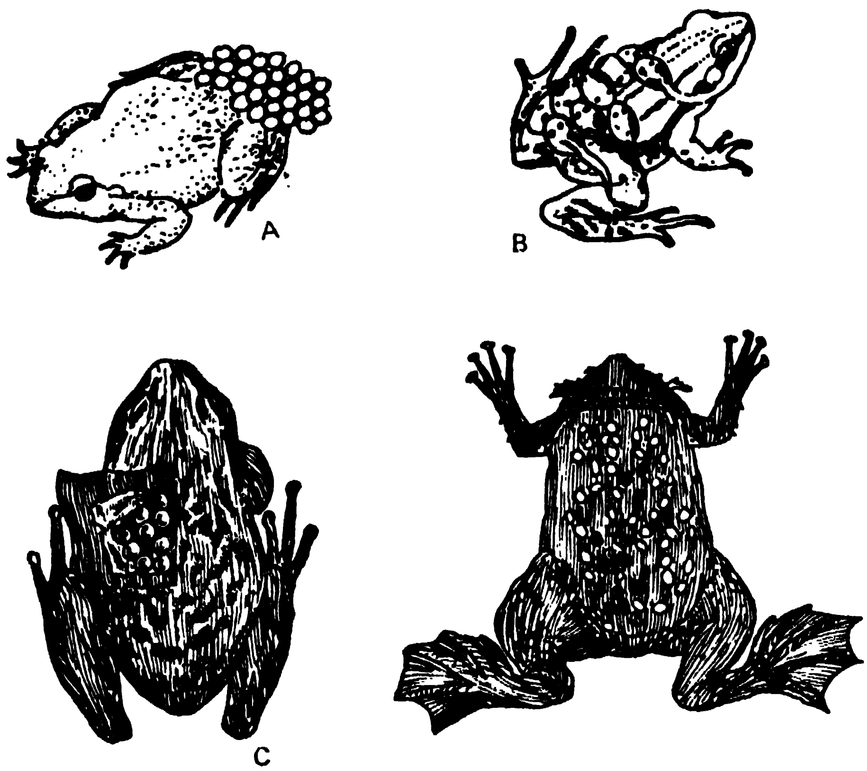

Fig. 6. Parental care in frogs and toads: A. *Alytes*, B. *Phyllobates*, C. *Gastrotheca*, D. *pipa*

In Western countries, even nursery school children collect egg masses and larvae (tadpoles or pollywogs) and watch them grow from aquatic fish-like form to terrestrial frogs through a series of dramatic changes called "metamorphosis". Therefore it is not surprising that much has been learnt about amphibians of Europe and America through systematic observations by amateurs. Breeding time is announced by loud rattling croak of the male. The call is species specific. Usually males arrive in the spawning area first and begin their calling. The females arrive, responding to the call of the males to a great extent. With a sudden leap, the male lands on her back encircling her body with the forearms, resulting in "amplexus". She lays her eggs in water or damp places on land while the male deposits the sperms over the eggs. The fertilization is external. The form of egg deposition is species specific, some in chains, some in clusters and some in foam nests (Fig. 3). The size and the number of eggs also vary according to the species. Some lay a dozen eggs and some, like the American bullfrog *Rana catesbeiana*, lay upto 25,000 eggs. The eggs are covered with layers of transparent protective jelly which helps them stick together. On emerging, the tadpoles attach themselves to the jelly but do not feed. They develop external gills for respiration. After 2-3 days the mouth opens and the tadpoles begin to feed on weeds and algae. External gills get covered by a membrane called operculum opening to the outside by a tube called spiracle. The respiration is done by the internal gills.

Tadpoles are primarily vegetarian and as a result the intestine is very long and spirally coiled (Fig. 4). Within a few weeks the hind legs develop. Emergence of foreclimbs marks the beginning of metamorphosis during which the tail gets absorbed, the skin is shed along with the larval lips and horny jaws leaving a much wider mouth (Fig. 5).

The diversity of the modes of reproduction in frogs and toads is impressive (Fig. 6). The male midwife toad *Alytes* carries the strings of eggs by the hind legs until the tadpoles are released into water. In *Rhinoderma* and in *Phyllobates* the male carries the tadpoles in the vocal pouch and on his back respectively. In the marsupial frog *Gastrotheca*, the male crams the eggs into a marsupium-like pouch on the back of the female. In the Surinam toad, *Pipa*, the male places the eggs in the dermal pockets on the back of female. In the Australian frog, *Rheobatrachus*, tadpoles develop inside the stomach of the mother and after metamorphosis, juveniles are "spitted out" by the females.

Status of amphibians

Until man interferes with the habitat, the wild amphibian lives in harmony with nature. There is no record of any amphibian species being threatened on a large scale by natural disease. Occasionally local populations are destroyed by droughts, out of season freezing or flood. But usually populations

"*You have not discovered a new amphibian, Miss Anita. That is only a dead wood floating on the water.*"

recover once the environmental factors are stabilized. Man has made survival of the frog difficult in many ways. Habitat destruction by drainage programmes, urbanization, road construction, pollution and collection of large number of frogs have reduced frog populations all over the world. In U.S.A., many states have laws which prevent both the catching of frogs in the breeding season and the unlimited collection at other times. Special Amphibian Facilities have been established in Japan and U.S.A. to optimise conditions for raising amphibians. It is difficult to assess the status of amphibians of India because very little information is available on their habits, behaviour and life cycles. There is even disagreement regarding the number of species indigenous to India. A thorough inventory of local amphibians is badly needed. In the midst of our "save the Tiger" or "save the Crocodile" projects where emphasis is on the large, conspicuous and exotic, we are ignoring the existence of our unique amphibians which benefit us in so many ways.

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EXTRATERRESTRIAL LIFE

(*Continued from page 506*)

Hope amidst confusion

The first results from the three experiments in the miniaturised biology package reached on August 7, 1976 and the Jet Propulsion Laboratory (JPL) in Pasadena, California, saw one of the most exciting sessions in the search for signs of life on Mars. The initial results were fully consistent with the metabolic activity of microorganism in the Martian soil. This was followed by an extremely puzzling activity displayed by soil samples. The unexpected fast reaction recorded in the second and third experiments took the JPL scientists off their guard. Instead of a slow, steady flow of carbon dioxide released from the radioactive nutrients, there was a rapid gush of gas during the first 10 hours of incubation following nutrient injection which dried up after about 70 hours. Had the earth microbes been in the test system they would have released the gas at a slower rate lasting for perhaps 10 days. In the gas exchange experiment, the equipment detected an evolution of oxygen at an extraordinary rapid rate. The results of the photosynthetic studies also indicate moderate incorporation of radioactive carbon dioxide, as would be expected from sparse life in soil from the dry Antarctic deserts. The cause of such incorporation, however, remains unknown.

The implications of these observations are presently thought to be more due to subtle chemical interactions rather than biochemical reactions. Martian surface is perhaps rich in oxidising chemicals, superoxides and peroxides. These chemicals give off oxygen when moistened and warmed and would cleave organic molecules to release carbon dioxide. However, formation and high concentration of peroxide on the Martian surface is something mysterious. Studies are under way to solve this riddle through the synthesis of information from many independent sources, including experiments that are being planned on earth to simulate the Martian environment and to study the reaction therein. Dr. Jerry Hubbard, a member of the JPL's biology team, while summing up the existing sentiment among scientists recently remarked "It is easier to think of it all in terms of chemistry rather than biology, even though we do not understand the chemistry". As it stands today, while the red planet has brought nothing but disappointment for the biologists, it has nevertheless presented the chemist with much more than they would have ever expected. But even, a complete negative finding for the biologists happens to have its own positive impact. Failure to find life in Mars, carbon-based or otherwise, according to Dr. Carl Sagan of Cornell University, U.S.A., is similar to finding "the classical scientific situation, the *experimental* and the *control*". May be, in future Mars will serve as a "control" to answer that big question—"Why did life originate solely on Earth in this solar universe?"

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SCIENCE SPECTRUM

Black hole quantized !

ONE of the most mysterious objects in the universe is the black hole. Only indirect evidences are available about its presence and yet on paper it shows itself out prominently with two striking characteristics. One is that no physical laws that we know, for example, laws of gravitation and motion, are valid on its surface! The other is that it is gravitationally so strong that even light cannot escape from its clutches! Till now, therefore, a black hole was literally taken as a black hole. Recent researches, viewing it from quantum mechanical angle, however, attribute to this "space-time" hole colourful possibilities. So much has been speculated about this hypothetical object that it now seems likely to be soon detected and from its study a better understanding of both microcosmos and macrocosmos could be had.

That there are similarities between the properties of a black hole and laws of thermodynamics, that it emits radiation just as an ordinary hot body does, that when it "vanishes" it explodes releasing energy equivalent to many millions of hydrogen bombs—are the possibilities scientists are now talking about. Let us first understand how this "illegitimate" hole is born in the world.

Birth of a black hole

Black hole could readily be called the reincarnation of a star after its death. A star remains alive till its nuclear fuels last. During most of its life it burns hydrogen to form helium—generating heat. The heat expands the gaseous atmosphere of the star keeping in check the gravitational forces trying to "choke" it from all directions. But when the nuclear fuels get exhausted, enough heat is not produced to check the gravitational "choking", and the star begins to collapse— literally. Slowly, as the star collapses, its radius goes on decreasing while its gravity rises. Eventually, the gravity becomes so large that it does not allow even light to escape.

It is a much talked about fact in spaceshots that to get out of the earth's gravitational pull, a spacecraft has to achieve a velocity of 11.2 kms/sec. This is called the escape velocity. For a star, say, of a mass ten times the sun's, the value of this velocity could be 1000 km/sec. When it begins to collapse, with the increase in its gravity, the escape velocity also rises. In the final stage of collapse, when it has reincarnated itself into a black hole, the escape velocity at its surface assumes a value of 300,000 km/sec. Apparently, light, having this velocity, is unable to overcome the gravitational pull of the object and thus hovers about it. Its uppermost wavefront hovers about it at a critical radius (called Schwarzchild radius) of 30 km assuming that the mass of the star is ten times the sun's.

This boundary of black hole, where the last wavefront of light hovers just as the uppermost layer of earth's atmosphere does, is called "Event horizon". So called because upto this horizon no knowledge of the events happening on the black hole could be studied. It is the surface area of event horizon which brings to notice many of the properties recently discovered.

Black hole and thermodynamics

Entropy, we know, is a measure of the degree of disorder in a system. The more there is disorder in a system, the higher is its entropy. Take, for example, two vessels containing two types of molecules, one vessel contains molecules at a degree of disorder or entropy A, and the other B. Connect the two vessels so that they mix. What happens while mixing is that molecules of one type link with those of the other type in a large number of ways. More disorder follows. So when the entropy of the "mixed" molecules is calculated, it is found to be higher than the mathematical entropies of individual molecules, just as two separate noises, one shrill and the other drone, if listened to separately would not appear as much noisy as when listened to together.

Mathematically stated, the above conclusion is somewhat like this. The entropy of (A+B) is greater than (or equal to) the sum of entropy of A plus entropy of B. Now take the case of black holes. They behave just as the molecules do, in a somewhat different context. It is found that when two black holes merge, or some matter gets itself "absorbed" by a black hole, the event horizon of the product black hole is always higher than the mathematical sum of the individual event horizons of the two. This parallelism between the properties of black hole and the laws of thermodynamics raises some questions and provides insight into the nature of a black hole.

It is further known in thermodynamics that any increase in the entropy of a system, like the "mixed" molecules, is accompanied with a corresponding increase in the energy of the system. In the "mixed" molecules' case, this energy increase can be thought of as the driving force required by the molecules to mix spontaneously. Apparently, the increase in the energy of a system is directly proportional to the increase in entropy. If these two are equated, there comes in a proportionality factor, which is here the temperature of the system. Likewise, this reasoning is followed up in a black hole.

The surface area of event horizon is $\frac{3}{4}\pi$ (Schwarzchild radius)^2. And as Schwarzchild radius is $2GM/c^2$, the surface area of event horizon is proportional to the mass M of the star. So if an increase in the mass of a black hole is equated to the corresponding increase in event horizon, there appears a proportionality factor that links them. This factor is the surface gravity of the black hole at the event horizon.

Now if the event horizon is analogous to entropy, the surface gravity is analogous to temperature. The resemblance between the latter two is further strengthened by the fact that like temperature, which is the same everywhere in a body at thermal equilibrium, the surface gravity of a black hole is the same on all points at its event horizon. Does this mean that the surface area of event horizon could be a sort of entropy of a black hole? In 1972, Jacob D. Bekenstein, of Princeton University, U.S.A., provided the answer.

A black hole has no hair

The sub-heading is not a parody composed by Bekenstein but, quite surprisingly, a theorem, an answer to what the entropy of a black hole could mean.

The more the disorder, the lesser is our ability to know about a system precisely. In other words, as the entropy of a system increases, the more the information about it gets irretrievably lost to us. Entropy of a black hole means just that. Any person believing in reincarnation very well knows that the soul of a person after death gets into another body with the difference that it forgets everything about its previous life. Similar things happen in a black hole with slight changes. A black hole retains only three of its "soul" qualities, namely, mass, angular momentum and electric charge, after the reincarnation and loses everything else about itself. It doesn't "know" whether it had formed out of matter or antimatter, from a spherical shape or highly irregular shape, etc. This degree of information lost, or disorder created, is called the entropy of a black hole. It has been found quantum mechanically to be finite.

Having understood what entropy of a black hole is and having known that it is finite in value, it is easy to infer that such a body has to have a finite, other than absolute zero, temperature. And as entropy of a black hole is proportional to its event horizon, the temperature of the black hole is proportional to its surface gravity. In a state of thermal equilibrium a black hole therefore should emit radiations. From the classical point of view this is not possible, and that is why Bekenstein theorem for some time received no notice until S. W. Hawking, of University of Cambridge, U.K., (*Scientific American*, January 1977) showed this phenomenon to be happening in reality—mathematically, of course. His calculations led him to believe that a black hole does emit radiation like an ordinary hot body and its temperature does depend upon its surface gravity. But how does all this happen ? This "business" is explained in the seemingly bizzare quantum mechanical manner.

Radiation and explosion

That pairs of virtual particles and antiparticles, whose existence has been indirectly observed, are being continuously filling the space is a well-known fact. These particles within a very short time materialise in space out of "nothing", separate, and then annihilate each other to vanish to "nowhere". Take, for instance, such a pair of particles being produced in the vicinity of a black hole. One of them is attracted and thus "absorbed" by the black hole. The other, if it is left out, escapes to infinity. It is this latter particle that appears to emanate from the black hole as radiation. Or, an anti-particle, i.e., a particle travelling backwards in time, falling into a black hole could be taken as the one coming out of it but travelling backwards in time. If it gets scattered gravitationally, where it was originally produced, it travels forward in time, as it were being radiated out of the black hole.

Just as we have potential barriers a round atomic nuclei, a black hole, too, has one. The influencing strength of this barrier is proportional to its size. The larger a black hole, the stronger is the barrier, lesser thus is the number of particles able to tunnel, quantum mechanically, through it as they do through nuclei. And when lesser is the radiation emitted by a body, the lower is the temperature of the body. Estimations tell that a black hole with a mass equivalent to sun's has an insignificant, cold temperature of ten-millionth of a degree above absolute zero. On the other hand, a black hole with a mass equal to that of a mountain, say, a billion tons, has a temperature of 120 billion degree K. Such a small sized black hole, of the order of 10^{-18}, would radiate energy equivalent to 6,000 megawatt, the output of six large nuclear reactors! So the existence of a large black hole would not be, because of absence of any tangible radiation, detected, while that of a small one would be far easier to detect.

It is apparent that a large black hole in time would "disintegrate" into a small black hole because of the radiation however minute it may be, and it would finally blow up. This blow up may be better termed as an explosion, because a black hole would blow up releasing millions of megaton of hydrogen bomb energy. The black hole explosion, it is now claimed, will prove to be an effective tool in probing into fields of particle physics and cosmology.

How much powerful a black hole explosion would be, it is now established, would depend on the different number of species of elementary particles in existence. As contemporary theories differ, one claims all particles to be made up of six different kinds of quarks (a basic particle), and other says there are infinite number of elementary particles—observation of a black hole explosion would tell which theory is correct. In fact, there is no other test to probe into the matter.

Telling about big bang

It is claimed that, though only within the last few decades we have come to realise, quite hypothetically, the presence of black holes, they have existed in the universe since it was formed. We now know that "Big Bang" occurred and formed the universe. In other words, a highly compressed region of dense material exploded with a bang to produce the universe. Fragments of material got scattered in all directions, some of which were so dense that they immediately collapsed to form minute black holes, called specifically "primordial black holes". Having small masses, they radiate copiously to be easily detectable. Statistical probability tells that such a black hole might be lurking somewhere about the orbit of planet Pluto. Having the knowledge of when the universe was formed and knowing what time a black hole takes to explode, it has been estimated that primordial black hole must be at present emitting hard γ-rays with an energy of 100 million eV. This clue would certainly enable us to trace it out. As an intriguing possibility, could not be the recently detected cosmic γ-rays (*S. R.*, June 1977), whose origin is still debated, the emissions of such a black hole in our vicinity? The *Cygnus X*-1 X-rays source, which is presently considered to be containing a black hole, also needs constant vigil for such signs. Further, as a black hole explosion is in characteristics similar to the Big Bang, much could be gauzed from its study about the formation of the universe. Is it possible that like black holes, matter first collapsed and then with a bang exploded to form the universe?

DILIP M. SALWI

Uranus and its six satellites

ORDERWISE uranus is the seventh major planet from the sun; the other six are Mercury, Venus, Earth, Mars, Jupiter and Saturn. It is revolving round the sun at an average distance of 2880 million Km, or in other words 19.182 astronomical units. One astronomical unit is equal to the mean distance between the earth and the sun. This is 148.6 million Km. The symbol for the planet is H. Uranus was the first planet to be discovered by telescopic observations. Not known to ancients, it was discovered by William Herschel on March 13, 1781. He thought it was a comet.

The planet is visible without a telescope, but appears as a very faint star. Earlier astronomers like Flamsteed, Lemonnier and Tobias Mayer had observed it as early as 1756 and thought it to be a faint star.

The discovery marked the commencement of series of brilliant discoveries which adorned the astronomical career of William Herschel. The orbit of Uranus is a flat ellipse. Its rotation about its axis is very fast, the day of Uranus is of 10 hours and 49 minutes. The revolution about the sun is very slow taking 84 years or, more accurately 30,685 days.

Six satellites revolve about Uranus in the equatorial plane which is tilted at such an angle to the ecliptic plane (the plane containing centre of the sun and the planet) that the satellites appear to revolve in a retrograde sense, i.e., they appear to rise in West and set in East. The two outer satellites are Titania (U III) and Oberon (U IV), diameter about 1,000 km. The next two Ariel (U I) and Umbriel (U II) are 700 km in diameter, while Miranda (U V) the fifth satellite is only 300 km in diameter.

The first two satellites were discovered by Herschel in January 1787, the third and fourth in 1851 by William Lassel at Malta and the fifth and then innermost satellite was discovered 97 years later by G. R. Kuiper in 1948.

The sixth satellite or a group of four extremely small satellites was discovered on March 10, 1977 by J. C. Bhattacharjee and Kuppuswami of the Kavaloor observatory of the Indian Institute of Astrophysics, Bangalore. According to them the new satellite is about 30 km in diameter and is the innermost satellite of Uranus. The observations were carried out with the help of 102 cm telescope at the Institute.

American astronomers led by Elliot do not agree with the findings of Indian scientists. They have detected a band of four satellites and not just one.

The observations of Uranus were carried out by Indians and American astronomers at the same time and by using a similar method called "Occultation". The Americans worked in an airborne observatory about 12,500 metres above the earth's surface. The aircraft flew over the Southern Indian Ocean when satellites were sighted on March 10, 1977.

The Indian and American scientists inferred the presence of a new object or objects around Uranus by using the occultation method. This involves measuring the intensity of light coming from a star beyond the planet Uranus. Indian astronomers found that the starlight suddenly began to grow dim indicating that some object had crossed the path of starlight. Since their calculations showed that neither the planet Uranus nor its five known satellites could have caused the occultation, they attributed the dimming of light to the presence of an unknown satellite.

American astronomers also found dimming and brightening of the starlight. But the pattern repeated four times indicating that it could have been caused by the quick movement of four satellites. They suspect that Uranus has a band of satellites close to it or a system of rings like Saturn. Until now Saturn was the only planet in the solar system known to be encircled by rings of space particles.

The new satellite is about 30 km in diameter and has a period of 10 hours. The sixth satellite of Uranus is yet to be named. The U VI cannot be seen even with a telescope as it is too small and too close to Uranus. Small satellites of the size of U VI were seen before only around the planets Mars and Jupiter. Astronomers have concluded that these extremely small satellites may be captured asteroids, as there is a region of minor planets called asteroids between Mars and Jupiter.

However, the present discovery of a small satellite at such a vast distance from the asteroidal belt is very interesting. It is very difficult, if not impossible, to capture asteroids from such a long distance.

The satellites bear the same relationship to planets as the planets bear to sun. The formation of a system of satellites may have a process similar to the formation of planets around the sun. It is also interesting to note that even though there are a number of major satellites around planets, no satellite is found to revolve around any other satellite. There are, of course, man-made satellites around our only satellite, the moon.

The satellites of the planets give the mass of the planet around which they revolve accurately. The mass of the planet can be estimated from a measurement of the distance from the planet and the orbital period. They also give information about the nature of the planets and the formation as well as evolution of the solar system. The tiny satellites of Uranus discovered by Indian and American astronomers are expected to add to our understanding of the mysteries of the solar system.

It is very difficult to detect small satellites such as the ones discovered, more so if they are at a far off distance as Uranus. Many small satellites were discovered in long exposure photographs of the sky taken for entirely different purposes.

According to M. K. Venu Bappu, Director of the Institute, and the only astronomer in India to discover a comet, the two observations of Indian and American astronomers are absolutely complementary to each other. He says that the discovery of a single satellite by Indians and a band of satellites by Americans was completely unexpected. Both the discoveries were made independently at about the same time and by similar techniques of measurement. The credit should be assigned jointly to Indians and Americans. An observatory in South Africa has confirmed the observations carried out by Indians as well as Americans.

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What is electrophoresis?

ELECTROPHORESIS is one of the most important methods used for separation of substances of different ionic properties. The term 'electrophoresis' derived from Greek means "borne by electricity." Alexander Reuss (1897), a Russian physicist, was one of the earliest

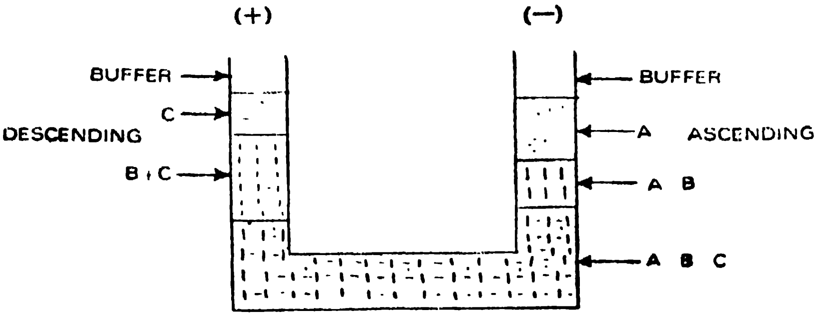

Fig. 1

investigators who studied the principles of electrophoresis. He observed the movement of colloidal clay particles when electricity was passed through a glass tube containing clay and water. Since then a host of workers developed the theory and methods of electrophoresis for applying it to laboratory problems. This technique has been extensively applied to the separation of some biological macromolecules since 1899.

The rate of migration of a molecule in an electric field is largely dependent on the net charge; the rate of electrophoretic migration will depend on the pH in the same manner as does the degree of ionization. In other words, in a mixture of proteins, each protein with its characteristic surface electrical charge will respond to an applied electrical potential in a different and characteristic manner at a given pH. The wide choice of pH and its effect on the electrical charges on a protein molecule lends great versatility to the technique of electrophoresis and allows a critical evaluation of the number of components in a protein. Although the absolute rate of migration is essentially contingent on the net charge, the shape and size of the molecule also influence the rate of migration.

The procedures

The two fundamentally distinct electrophoretic procedures are: (a) electrophoresis in free solution, and (b) electrophoresis on supporting media (filter paper, starch, polyacrylamide gels). Microscopic electrophoresis (a type of electrophoresis in free solution) involves direct observation and measurement of migration of particles in a solution or suspension contained in a glass tube placed horizontally on the stage of a microscope. The method as such is applicable to blood cells, protozoa, bacteria and colloidal particles. Moving boundary electrophoresis (another type of free electrophoresis), which involves measuring the movement of the boundary of a mass of particles, has brought in a new era of biochemical research in the past 30 years. This method owes its development to the pains-taking research of Arne Wilhelm Kaurin Tiselius of Sweden who was awarded Nobel Prize in 1948. The material to be studied is placed in a U-tube (Tiselius apparatus). On top of the protein solution, in the two arms of the U-tube, is carefully layered a buffer solution so that there is a sharp boundary between the two solutions. An electric current is passed through the solutions by means of a positive electrode (anode) inserted in one arm of the tube, and a negative electrode (cathode) in the other. The entire U-tube is immersed in a bath maintained at a constant temperature near 0° C in order to minimize convection currents produced by heat generated by passage of electric current, and to prevent heat coagulation of sensitive proteins. Consider homogeneous protein solution having three components A, B, and C. If the components A, B, and C carry charges of the same net sign (positive or negative) but of different magnitudes (or numbers), the components will migrate at different rates and separate themselves. If the magnitude of electric charge is in the order A, B, C, the components will separate as explained below.

The faster moving component A will be present in the pure form in the ascending boundary, whereas C will be present in the pure form in the descending boundary; however, B will be mixed with A or C.

The measurement of the movement of the boundary was first augmented by the development of Schlieren optics—a method based essentially on the fact that at a boundary between two transparent materials

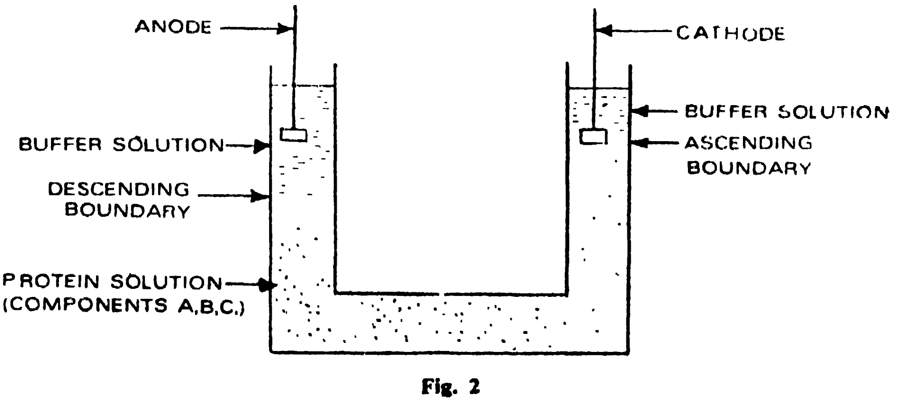

Fig. 2

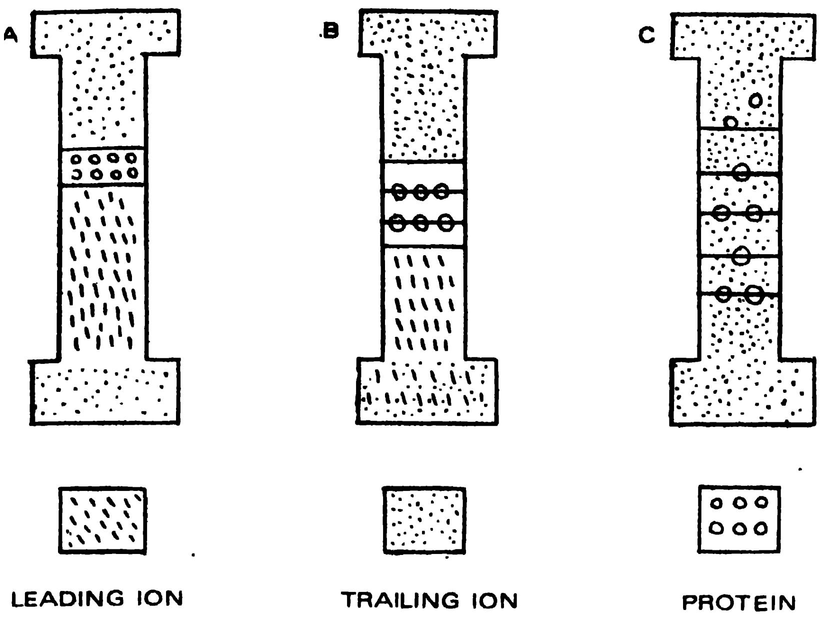

Fig. 3

of different density the light rays are so refracted as to produce "shadows" which indicate the location of refraction. "Schlieren Scanning Device" was introduced by Lewis G. Longsworth (Rockefeller Institute, U.S.A.) in 1939, which gave a more comprehensive picture in the form of "peaks and valleys", each peak representing the position of a boundary in the moving column and the area under the peak representing the concentration of the chemical fraction responsible for the area under the curve. With pure substances, only a single symmetrical peak was obtained (in the form of a bell-shaped curve); multiple peaks and asymmetrical curves indicated mixtures.

A basic equation defining electrophoretic mobility (μ) in terms of the moving boundary is :

$$\frac{dx}{dt} = \mu E$$

dx=distance travelled in time dt under influence of electric field E (distance in dimension of cm).

dt=in seconds

E=volts/cm

The most important problem in electrophoresis, as mentioned above, is the dissipation of heat generated by the passage of current; not only are most biological substances thermolabile, but unequal heating produces conversion currents in free solution resulting in uneven migration boundaries.

Disc gel electrophoresis

Since electrophoretic mobility in free solution at a given pH is a function of the net charge density on the protein molecule, several molecules of different shape and size may exhibit the similar electrophoretic mobility. If, however, electrophoresis is carried out in a medium that is provided with microscopic pores, the size and shape of the protein molecule become important factors. In this case, large molecules of high electrophoretic mobility may trail behind the smaller molecules of lesser electrophoretic mobility. In 1955, O. Smithies of the University of Toronto (Canada) developed methods for molecular sieve electrophoresis. He observed the additional resolving power provided by the sieving capacity of starch gels. This phenomenon led to the use of polyacrylamide gels.

Polyacrylamide gels show distinct advantages as an electrophoretic medium. 1. They are obtainable in highly purified form; 2. their pore size can be adjusted over a wide range by varying the monomer concentraion; 3. they are transparent over the range of visible light; 4. the gels are relatively inert chemically because their lattices are formed by carbon-carbon bonds with pendent amide groups with few or no ionic side groups; and 5. they are easy to handle and are fairly rigid in nature. Taking these factors into consideration, these polymers provide flexibility not available in the starch gel technique. In "disc" electrophoresis the system is not uniform in pH, buffer species and concentration and gel porosity. The salient characteristics of the technique reside in the controlled variation of the gel pore size for the purpose of increasing the resolution of ions based on dimensional differences, and provide an electrophoretic step for concentrating the sample ions into a narrow starting zone prior to electrophoretic separation.

The polyacrylamide gel column is composed of two layers. The small-pore, lower gel is the part in which electrophoretic separation occurs. This gel functions as a seiving device as well as an anti-convection medium. The seiving phenomenon comes about as a result of the differences in frictional drag of moving molecules of different sizes. The large-pore, upper gel functions to concentrate electrophoretically the sample ions. This spacer gel stacks the various ionic components of the original sample into contiguous zones in the order of their relative mobilities. This, thereby, decreases diffusion and increases resolution.

The polarity of the electrodes in the two buffer basins is arranged so that the ions migrate toward the small-pore gel. After voltage has been applied, the gel is removed and stained with a protein-binding stain. Unbound stain is removed by washing or by electrophoresis, thus leaving the various stain-bound proteins in clearly definable bands.

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Termite mound and ground water exploration

TERMITES, popularly known as white ants, are a part of the extensive fauna that exists throughout the tropical and in most of the warm temperate countries. Their estimated number of species is 2,000. Food of termites is mainly wood and woody tissues of plants, so they cause immense damage to buildings, furniture, clothes and crops. Further, in some regions, they build small mounds of soil which prove serious obstacles to agricultural and civil engineering projects. Efforts have been made to eradicate them or immunise articles against their attack.

However, there are some beneficial effects of termites too. The soils of their mounds are, used for making ovens, bricks, and pottery; for plastering walls, surfacing roads, pavements, and tennis courts. Termites are used as food in certain parts of the world because they form a useful source of animal protein.

Termites live in soil. For some, the habitat is a network of chambers made below the ground with little or no indication of their presence on the surface. Others build conspicuous mounds varying from a few cms to more than 9m in height. The construction material of the mounds are sandy particles of the subsurface soil carried in their jaws to the site and cemented with a mixture of clay and saliva. Beneath the mound, under the ground, a complex pattern of corridors (Fig. 1) is made through which termites move in search of woody food and building materials. The termite mound is constantly renewed, enlarged, or even shifted to suit the environment.

When food supplies are not accessible through tunnels in the ground, termites use covered runways on the nearby trees (Fig. 2). Such covered runways are built in the same way as the mounds on the ground and constitute an extension of the mound construction. The colour, texture of the soil, and the architecture of the termite mound vary widely and depend upon: (1) the nature of the subsoil; (2) climate, and rainfall; and, (3) the behaviour of the particular species of the termite.

The interior of a termite mound consists of a number of chambers and

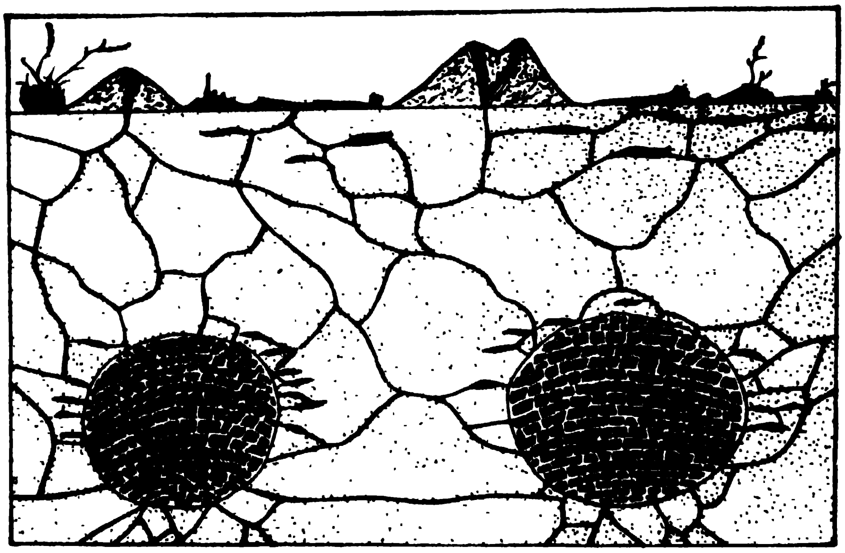

Fig.

Fig. 2

partitions to provide an elaborate system of ventillation to meet the requirements of their microclimate.

As has already been pointed out, the termite mounds represent an equilibrium of three forces—behaviour, material, and climate. A species, which is restricted in its distribution to a particular ecological zone where environmental factors such as soil and climate are relatively uniform, builds mounds of uniform shape. On the other hand, a species occurring in a wider range of habitats builds mounds of variable appearances. The architectural style of a termite mound is of great significance in environmental science which, from ecological point of view, deals with the sum of all external conditions and influences affecting the life and development of organisms.

In certain regions, the land is covered with a thick and featureless blanket of soil. In such places, prospecting for minerals is difficult due to scarcity of bed rock exposures. Geochemical prospecting, involving trace element analysis of the surface soil or such metals as nickel (Ni), molybdenum (Mo), and tungsten (W), indicate the probability of their presence in the parent rocks occurring below the soil. The soils of the larger termite mounds, with their large proportion of unweathered subsoil, are a helpful clue in the exploration of economically important mineral deposits.

The most important use of the termite mound is in ground water exploration. In this connection, reference to the ancient Hindu Literature, *Brihat Samhita* by Varahamihira (A.D. 505-587) is highly significant. The Sanskrit text of *Brihat Samhita* deals with astronomy, astrology, and various other sciences. Its 54th Chapter entitled *Dakargalam* deals with the ground water exploration with a multidisciplinary approach involving various disciplines in earth sciences and life sciences. It describes termite mounds together with certain plant species as hydrologic indicators.

Termites are susceptible to desiccation. Therefore, maintenance of high humidity in the termite mound is an essential requirement for the survival of most species of termites, especially those living in arid and semi-arid regions. Active transport of water is one of the important mechanisms contributing to humidity control of the termite mound. A. Buillon (1970) of U.S.S.R, has pointed out that free water in the soil and from the water table, even when it is very deep, is one of the sources of water used by the African termites. Also, the connection of the termite mound, through its subterranean 'galleries', with the ground water source has been demonstrated by other workers.

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The mysterious scattering layer

ECHO sounding machines have been employed for measuring the depths of oceans instead of the conventional lead and line method since the Second World War. Sound waves sent out from the echo sounder reflect back after striking the ocean bottom. A continuous record of the depth is maintained as the survey ship moves along. This method of charting the ocean depths appeared simple and free from any trouble at first. Soon the charts began to show profiles of depths shallower than real. The mystery further deepened when this false bottom was found to migrate up and down. It became evident that something scattered the sounds at depths. Its existence spread for thousands of kms and was recorded in the Altantic, the Pacific and the Indian Oceans. This layer of doubtful existence was soon named the Deep Scattering Layer or D. S. L. in short.

Deep Scattering Layer mystified biologists for a while. The living creatures are abundant only upto a depth of about 200 metres where minute plants of the plankton can synthesise food from sunlight. Population density of living creatures below this depth tends to decrease. The Deep Scattering Layer presented the possibility of enormous quantities of living marine resource ready to be tapped. However, the exact nature of resource could not be established for a long time. Nets and remote control cameras operated at these depths could not provide definite clues. Finally scientists descended the ocean depths in pressure resistant equipments (bathyscape) to observe organisms responsible for scattering the sounds directly. Dense concentrations of floating jelly fishes (siphonophores), swarms of shrimps and small lantern fishes in huge shoals greeted the diving scientists at different depths. The mystery of the Deep Scattering Layer was solved from a biological point of view.

In Indian waters the D. S. L. is known to occur at depths varying from 700 metres to 900 metres. The living populations at these depths are small prawn-like euphausiids, midwater fishes and shoaling cephalopods. A detailed study of the D. S. L. is required for further assessment of populations available for future exploitation.

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Hormones influence animal behaviour

STEROID hormones play an important role in physiological regulations in animals. They are sécreted by adrenal cortex or by gonads and are potent substances. Steroids from adrenal cortex help regulate utilization of electrolytes such as sodium and potassium in the body. In addition, adrenocortical hormones also affect the mood of an animal. Similarly, gonadal steroids which primarily act on tissues associated with sexual functions like those of vagina, uterus, breast and the oviducts in female, and the prostate, seminal vesicle in males, also play an important role in sexual behaviour. We will discuss some observed effects of gonadal steroids on animal behaviour.

Removal of gonads in males (castration) seriously affects sexual behaviour in all vertebrates, although a sexually experienced animal may enjoy some aspects of sexual behaviour for long even after castration. However, castration before puberty has a profound effect on the sexual behaviour. For example, in pre-puberty castrated rat, penile intromission does not occur though the animal may display some related behaviour such as running around a female and even jumping on her. Several such examples can be cited about male hamsters, guinea pigs and cats. A monkey becomes sexually impotent 4 or 5 months after castration. All the lost masculine characters can again be restored by androgen treatment. Castration in females eliminates estrous cycle and sexual receptivity which can be restored by administering estradiol. Steroid hormones have also been shown to be effective in regulating the parental behaviour in some animals. In night heron, in which parental activities are performed jointly by the male and the female, testosterone, but not the estradiol, was found to initiate nest-building in both sexes.

The question left to be answered is : How do steroid hormones affect animal behaviour ?

Extensive investigations have revealed that all behavioural effects of steroidal hormones are mediated by brain. It is now well established that sex hormones directly influence sexual differentiation in brain by affecting the pattern of nerve connections, and the organizations of nerve circuits in specific parts of the brain during embryonic and early post-natal life. For example, if a male rat is castrated at birth, the sexual differentiation of nerve circuits in brain fails to take place and the brain retains "female" pattern. Similarly, administration of testosterone to a newborn female evokes a "male" pattern of brain because

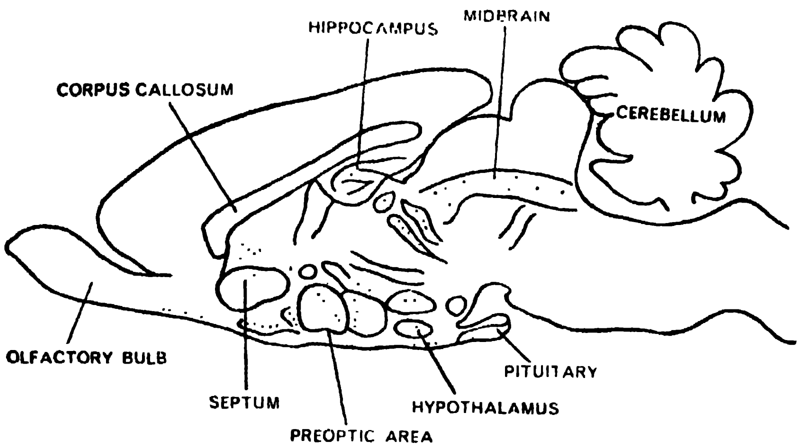

Fig. 1. Dotted areas show incorporation of tritiated estradiol

administered testosterone is readily converted intracellularly into estradiol. However, sex hormones cannot modify the nerve circuits in the adult animal but can influence the circuit's functional efficiency and, in turn, control the behaviour.

Professor Arnold A. Berthold (1949) of the University of Göttingen has suggested that gonadal steroids directly influence the brain functions. He found that castrated roosters no longer crowd, fought or exhibited sexual behaviour. These symptoms were however restored when testes were transplanted into abdominal cavity of castrated roosters. On the basis of this experiment, Arnold concluded that behavioural signals from testis reach the brain through the blood and not through the nerves. The findings of Arnold were confirmed by Ronald J. Barfield (1969) of Rutgers University. Professor Bruce S. McEwen and his co-workers of Rockefeller University have located different specific steroidal-hormone-sensitive regions in the brain. Donald W. Pfaff of Rockefeller University and Walter E. Stumpf of the University of North Carolina

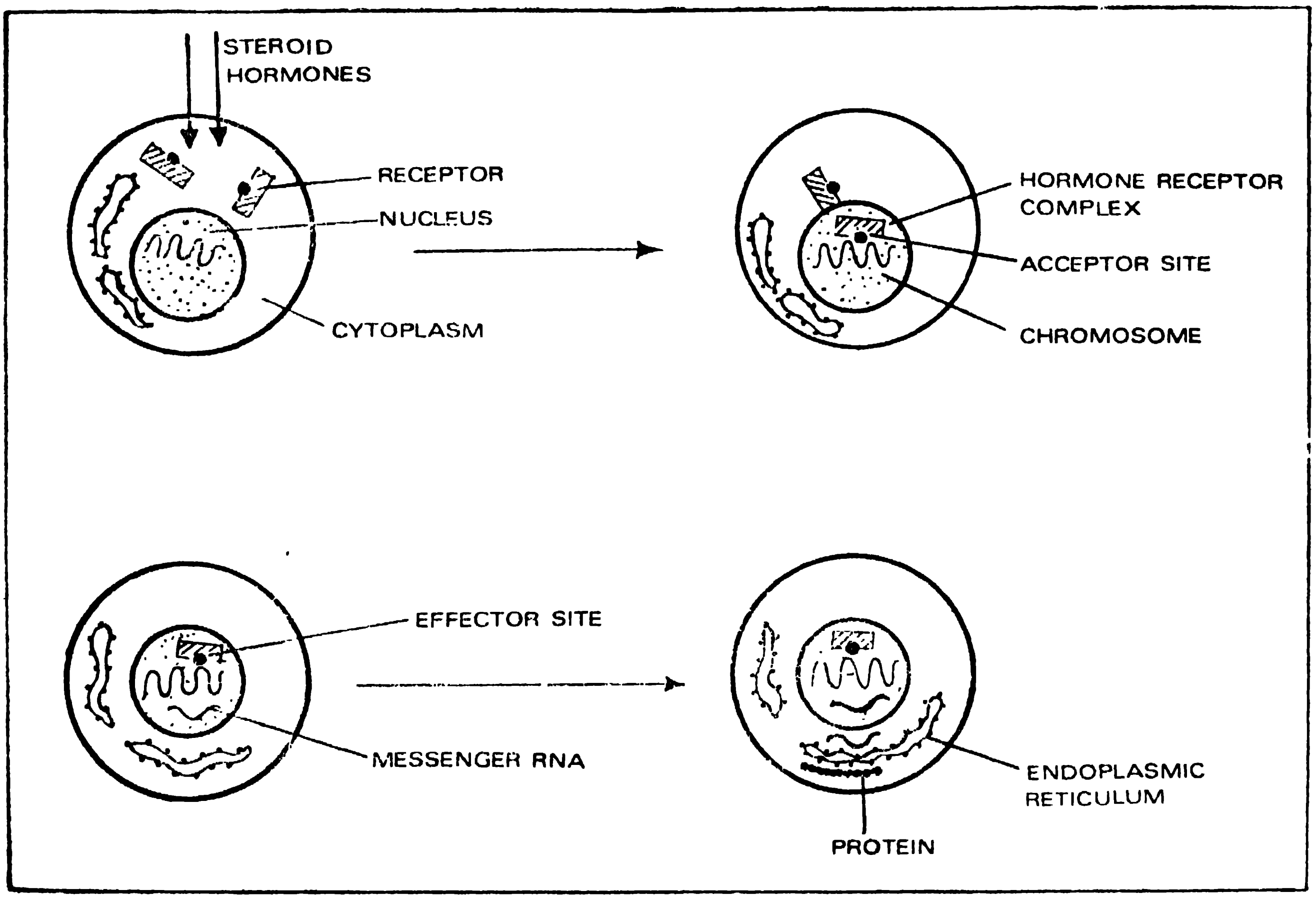

Fig. 2. Mechanism of action of steroid hormones

found the highest density of estrogen concentrating cells in the pre-optic area of the brain, the hypothalamus and its adjacent area, and the amygdala in the brain of castrated female rats with the aid of autoradiography technique (Fig. 1). Pfaff and Joan I. Morrel also observed a similar pattern of distribution of estradiol-specific area in the brain of fishes, amphibians, birds and mammals. These specific regions of the brain are loaded with receptor proteins which can bind with estradiol. It is now well proved that testosterone can be enzymatically converted into estradiol and dihydrotestosterone. Enzyme responsible for this is present in all the steroidal hormone sensitive regions of the brain of a male rat except in the pituitary.

Larry Christensen and his colleagues of Michigan State University reported that the testosterone derived estradiol is responsible for the restoration of male sexual behaviour in castrated male rats. Dihydrotestosterone increases the effectiveness of estradiol in restoring the male sexual behaviour when both are given to castrated male rats. The brain of male rats has a large number of receptors for dihydrotestosterone too.

Does behavioural response involve metabolic changes in the brain ? Rogers A. Gorski of the University of California School of Medicine at Los Angeles and other workers have shown that small implants of actinomycin D (an inhibitor of RNA synthesis) in the pre-optic area of the rat brain reversibly block the facilitation of female sexual behaviour induced by estrogen. It clearly indicates the involvement of biochemical changes in the brain during behavioural response. The mechanism of action of gonadal steroid hormones, especially estradiol, is as follows. The steroidal hormones bind with their specific receptors and form hormone-receptor complex. This complex binds itself with the acceptor site on chromatin and, in turn, unwinds the DNA duplex which is ready for RNA synthesis. The synthesized RNAs are translated into proteins (Fig. 2). These metabolic changes within the target neurons determine the readiness for the behavioural response.

The mechanism of action of adreno-cortical steroids is not well understood as that of sex steroids. However, there are indications that adrenal steroids significantly affect the brain functions as revealed by the presence of receptor proteins in the hippocampus and septum regions of the brain. When adrenal steroids were administered into human volunteers, they profoundly affected the rapid eye movement (REM) of the volunteers characterizing a certain state of sleep. REM sleep (*S. R.*, June 1976) seems to be associated with dreaming. Recently, Professor J. Balthazart (1976) of University of Leige, Belgium, reported that the short-term changes in behaviour might also be caused by fluctuation in the hormone level. He recorded in winter the daily patterns of behavioural activities in two groups each with two females and five male domestic ducks housed in outdoor cages. He found that courtship and mating activity in one group decreased with simultaneous decrease in the level of plasma testosterone after early morning peak, although some of the other activities did not show a similar daily rhythm. He also observed a contrast between two groups with respect to hormone level. One group showed an increase in both display frequency (mating and courtship) and hormone level in the afternoon while the other group did not show such changes. However, the second group had a higher level of testosterone. He also found that behavioural differences between individual males did not relate to hormone level. On the basis of these observations, Balthazart gave an intriguing explanation for a mechanism of short-term changes in behavioural activities. But still it has to be shown that the changes in hormone level cause the behavioural changes rather than the other way round.

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3. Pfaff, Donald, Lewis, Catherino, Diakow, Carl and Keiner, Melvyn in *Progress in Physiological Psychology*, Vol. 5, edited by E. Steller and J.M. Sprague, Academic Press, New York, 1973
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Interferon system—body's non-immune defence

INTERFERON is the name which A.Isaacs (1957) gave to a substance with antiviral activity . In his experiments he demonstrated that chicken cells produced this susbtance when exposed to heat inactivated influenza virus. Subsequent investigations by numerous workers revealed that interferons are a heterogenous group of antiviral proteins and that interferon production was a very general response of cells to virus infection. These substances are released in the cell infected with a virus which then diffuse to neighbouring cells to provide protection against the virus which initially induced its production, as well as against other kinds of viruses. They are however cell specific. Interferon produced in mouse cells while protecting other mouse cells will remain ineffective against any viral infection in cells of other species.

Some non-viral agents like bacteria, rickettsiae, bacterial endotoxins, nucleic acids, nucleotides, nucleosides etc. have also been claimed to be inducers of interferon-like inhibitors. As these substances have not yet been adequately characterized, their precise classification is uncertain.

It is now generally believed that viral infections are held in check in animals as a result of this special defence mechanism. Interferons also profoundly arrest the transformation process in certain virally initiated tumors.

The interferon response differs from other immune responses, where protection is against foreign proteins, in that they protect cells rather specifically against foreign nucleic acids.

Interferons are proteins or glycoproteins in nature with a molecular weight ranging from 20,000 to 40,000. They are stable at moderate heat (about 60°C) and considerable range of pH values (pH 2-10).

Different viruses have been found to differ in their ability to induce interferon production in the cell. Most of the strong inducers of interferon belong to the myxovirus and arbovirus groups. The enteroviruses seem to be poor inducers of interferon. Extreme variations in virus susceptibility to interferons have also been noted. At the present state of our knowledge it is difficult to determine precisely what factor or factors are responsible for these variations in virus-interferon responses. Apart from the virus, the cell seems to be an equally important determinant of whether interferon is produced, how much of it is produced and what its biological action will be. It has been suggested that a virus must interact with the cell in order to be able to trigger interferon synthesis, and for such reaction to occur appropriate receptors may be necessary. The age of the cell can apparently have a profound influence on the ability to produce interferons. The evidences available unfortunately fail to establish whether a young cell is basically incapable of producing interferon or its failure to do so is because it gets killed before it is ready to synthesize the substance. Cells of the reticulo-endothelial system have been shown to have an important role in interferon production.

Studies of numerous scientists put together seem to suggest that the mechanism of interferon production involves four stages : (1) Virus invasion followed by release of inducer for interferon formation; (2) interaction of these inducers with host cell genome possibly leading to derepression; (3) synthesis of messenger RNA for interferon, and finally (4) synthesis of interferon proteins. There are evidences to suppose that a single site on cellular DNA controls the formation of mRNA for interferon synthesis. R.R.Wagner (1963)regards interferon synthesis as an example of formation of biologically active macromolecule by derepression. The actual stimulus for interferon production still remains unidentified. Speculations are that it might be the viral nucleic acid.

The mechanism of action of interferons in checking viral infection is not known. The fact that a virus incubated with interferon retain its infectivity suggest that the action is not directly on the virus particle, rather it affects the intracellular process involved in viral replication. Some scientists believe that synthesis of viral nucleic acid, or more possibly protein, is affected.

The facts that interferons are essentially non-toxic and are tolerated by animals to a great extent and that its inhibitory action is on a wide range of unrelated viruses have aroused considerable interest on the subject. There is hope of the possible application of interferons as "broad spectrum antiviral drug" in the near future. Local application of interferon has been shown to protect eyes, skin, peritoneum, respiratory tract and other sites against viruses in a number of animal experiments Interferons are also capable of preventing malignant transformation of cell by oncogenic viruses and are known to selectively destroy virally initiated cancer cells.

Past experimental evidences, along with researches in progress in the field, might open up new lines for successful clinical application of this component of our natural non-immune defences and ensure effective remedies against the as yet undefeated viral diseases.

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Rauwolfia serpentina—an indigenous drug plant

THERE is an increasing interest in the acquisition of new plant materials as sources of industrial raw materials. Naturally available plant extracts are less economic than artificially synthesized complex molecules of the laboratory. Extensive survey of potentially rich geographical regions, screening of plant resources, their conservation and utilisation is noteworthy. Scientists say, "A more elaborate analysis of the pharmacology of the plant shall

R. serpentina

bring out the truth of its mysterious manifold action." *Rauwolfia serpentina*, Benth., the wonder plant of antiquity, is the source of an alkaloid known as reserpine. It has aroused great interest for its hypotensive and tranquillizing principle. Roots of the plant are the source material from which the alkaloid is extracted.

Origin and morphology

The nativity of this medicinal plant is not clearly known. The root of *R. serpentina* has been much valued in India as well as in the Malayan peninsula from ancient times as an antidote to the bite of poisonous reptiles, stings of insects and also as a psychoactive material.

The plant is indigenous to Maharashtra, Gujarat, Tamil Nadu, Kerala, Karnataka, Punjab, Bihar, Orissa, West Bengal and Assam is an inhabitant of moist regions with rainfall range of 175 cm-375 cm a year and altitude upto 1300 metres. It belongs to the family Apocyanaceae (Vern.: Bengali and Hindi : Chotachand, Chundrika; Kannada : Amalpodi, Garudpathal; Marathi: Moogsavel, Sapasan; Oriya: Patalgaruda; Bihar: Dhanbarna; Sanskrit: Sarpagandha, Chundrika; Tamil: Eiyakundu; Telugu: Patalgandhi, Patalgarud).

It is a pretty, glabrous undershrub, 30-60 cm high with bright green, shining, opposite and 3-4 nately whorled, oblong or ovate membranous leaves, 7.5-15.5 cm long. Its small, white flowers have pink tubes in terminal peduncle.

Mention may also be made of two other species found in India namely *R. canascence*, L. and *R. densiflora*, Benth., for their useful alkaloids.

Chemical composition

As an authentic drug in the indigenous system of medicine, major workers of India and abroad have focussed their attention on roots, the main source of active principles. A detailed account is given in Table 1. The alkaloid reserpine currently

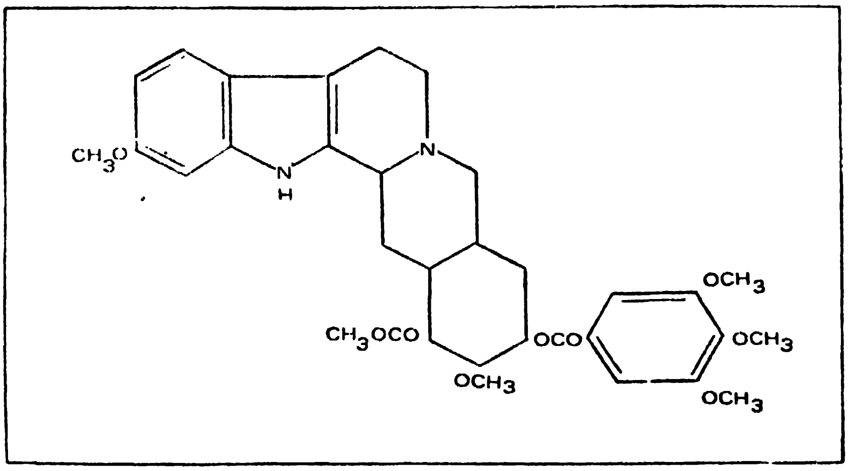


Fig. 2

Table 1. List of alkaloids detected and their properties

Alkaloid groups isolated	Locality	Source	Alkaloid contents	Physical properties
1. Two types of alkaloid alongwith resin and starch	—	Root	1% of the root	
2. Five types of alkaloids under two groups	—	Root		
A. *Ajmaline group*				White crystalline weak bases
(a) Ajmaline (C_{20} H_{26} O_2 N_2)			0.1%	m.p. 158-160°C.
(b) Ajmalinine (C_{20} H_{22} O_4N)			0.05%	m.p. 180-181°C.
(c) Ajmalicine			0.02%	m.p. 250-252°C.
B. *Serpentine group*				Bright yellow crystalline strong bases
(a) Serpentine (C_{21} H_{22} O_4 N)			0.08%	m.p. 153-154°C.
(b) Serpentinine			0.08%	m.p. 263-65°C.
3. Three alkaloids	—	Root		m.p. 160°C.
(a) Rauwolfine (C_{21} H_{26} O_2N_2)				
(b) Isorauwolfine				..
(c) Alkaloid of the type ajmaline				—
4. Alkaloids of different groups				
(a) Ajmaline, ajmalinine, and ajmalicine groups	Bihar	Root	--	White crystalline bases
(b) Serpentine and serpentinine groups	Bihar	Root		Bright yellow crystalline bases
(c) New ajmaline group, little ajmaline and ajmalicine	Dehra Dun	Root	..	-
(d) Isoajmaline and neo-ajmaline	Dehra Dun	Root bark	0.1%	m.p. 264-260°C.
(e) Isoajmaline and neo-ajmaline	Dehra Dun	Root	0.1% &1%	m. p. 205-207°C.
5. Total alkaloids	—	Root	1.21%—1.36%	—
6. Rauwofine (C_{19} H_{26} O_2 N_2)	-	Root	-	m.p 235°C.—236°C
7. Reserpine	—	Root	—	m.p. 202°C. 203°C. crystalline form
8. Total alkaloid		Root	1.7%—2.7%	
9. Total alkaloid	Dehra Dun	Root of 2 years diploid plant	1.54%	
-do-	Dehra Dun	Root of 2 years tetraploid plant	2.28%	—
-do-	Rishikesh	Root of 3 years diploid plant	2.28%	—
10. Total alkaloid	Bihar	Root	0.956%—2.72%	-
11. Total alkaloid	Rishikesh (U.P.)	Root	2.6%	—
	Rangoon (W.B.)	Root	2%	—
	Dehra Dun (U.P.)	Root	1.8%	—
	Calcutta (W.B.)	Root	1.35%	—

isolated (Fig. 2) has become commercially feasible for its psychoactive principles.

Besides the alkaloid contents, some other substances like resin, starch, potassium carbonate, silicate, phosphate, maganese, iron, phytosterol (C_{28} H_{44} O_2), oleic acid and unsaturated alcohols are also present. A long term research of about five decades provides the clue for extensive survey of potentially rich geographical regions for screening superior variety with a rich content of reserpine.

Alkaloid consumption in India

Alkaloid consumption in India is gradually increasing due to its higher commercial exploitation. A. Dutta and coworkers recommended from Calcutta (*Ind. Jour. Pharm*, 54, 1947) a standardised alcoholic extract containing about 0.5% of alkaloid for clinical trials. This extract or tincture manufactured by different commercial firms was used by the medical profession in India for the treatment of hyperpiesis and maniacal type of insanity. There is also a large scale production of reserpine by extraction from natural source as well as by biosynthesis from many pharmaceutical firms in our country.

Cultivation and ecophysiological studies

The plant *R. serpentina* occurs widely in nature in various habitats. Considerable variation in the alkaloid contents and consequently potencies of *R. serpentina* roots have been reported from time to time. The highest alkaloid contents is found at the end of the season when the fruits are ripe. At pre-flowering stage in the month of March, roots have the lowest alkaloid content and it increases till the end of the season. R. Dhar at Regional Research Laboratory, Jammu (*Proc. Ind. Ac. Sci.*,

1965) reported that there were considerable variations in the alkaloid content of four geographical races of *R. serpentina*.

R. C. Biswas (*Sci. and Cult.*, 1969, 1970) while working at Central Botanical Garden, Calcutta, reported an increase in the root alkaloids under defloration treatments with and without nitrogenous fertilizer to the deflorated samples. Such defloration procedure may be employed for commercial cultivation of *R. serpentina*.

Table 2. Pharmacological action of alkaloids

Alkaloid treatments	Experimental animals	Effect
1. Extracts of serpentine groups injected intravenously	Cats	Effective stimulation marked
2. Total alkaloid contents and serpentine groups	Guinea pig	Lowering the carotid blood pressure, depresses the cardiac musculature, produces spleenic contraction, stimulate respiration and increases peristalysis of intestine
3. -do-	Cats	Lowering the blood pressure
4. Alkaloid extract from roots	Cerebrate and spinal animals under experimental hypertension.	Stimulatory effect on nervous system followed by depression
5. Reserpine	Rabbits and dogs	Animals put to sleep
6. Reserpine	Man	Effective tranquillizing action during hypertension

Pharmacological action

The plant has attracted considerable attention not only in India but also in Europe and America and much work is being done on pharmacological action of different alkaloids in it.

The ajmaline group (Table 1) is a general depressant to the heart, respiration and nerves, and the serpentine group (Table 1) paralyses respiration and depresses nervous system but stimulates heart. These observations are based on experiments carried out on frogs and are not applicable in toto higher animals. Fresh reserpine is a strong and long duration central sedative. Small doses (0.01 mg/kg) administered intravenously to rabbits and (1 mg/kg) orally to dogs put the animals to sleep (Table 2). The drug is not an irritant when taken by mouth or when introduced into the system by hypodermic or intramuscular injection.

Sedative responses

Recently reserpine has gained popularity as a specific drug for treatment of in sanity as it possesses marked sedative properties. Powdered roots produce a good sedative effect. J. C. Gupta and coworkers (*Ind. Med. Gaz.*, 547, 1943) have treated fifteen types of mental patients, like organic psychosis, chronic-epilepsy and effective reaction types. All patients were suffering from insomnia and showed considerable mental agitation. After treatment patients behaved normally and there was considerable improvement in those suffering from mental disorders. Epilepsy was controlled and there was stimula tion of alimentary system. Appetite also improved.

Treatment of hypertension

Powered roots taken (20 gm to 30 gm) twice daily decrease blood pressure within a week. Reserpine is also valued as a major tranquilliser and is used in treatment of hypertension. The doses are: in psychiatric states 1 mg to 5 mg daily in divided doses; in the treatment of hypertension, 500 mg daily.

Drug interaction

There is an increasing interest in the study of interaction of *R. serpentina* with other drugs. K. Nadkarni (*Indian Materia Medica, 1*: 1050. 1954) reported use of *Aristolochia indica*, L. with *R. serpentina*, Benth. against cholera and found that the patients were cured. In treatment of colic, one part of the root with two parts of *Holarrhena antidysenterica*, Wall. and three parts of *Jatropha curcas*, L. in milk is given. *R. serpentina* root with *Andrographis paniculata*, Nees., *Zingiber officinale*, L. and black salt is prescribed against fever.

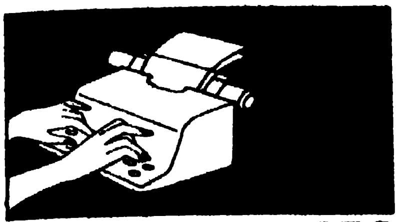
Ayurvedic use

Decoction of the root is used to increase uterine contraction and quicker expulsion of the foetus. Root is used as a remedy against poisonous snake bites and stings of insects. It is also a valuable remedy in dysentery and painful bowel complaints.

Current research programmes

Now steps are being taken by the Regional Research Laboratories at Jammu, Bhubaneswar and research workers of other organisations for a detailed survey of the

(*Continued on page 494*)



NEWS & NOTES

The neutron bomb

TWENTY FIVE years after the first hydrogen bomb was exploded in 1952 comes the news of the testing of a 'neutron bomb' by the United States. The new device, developed after 20 years of research, is in fact the first major breakthrough in nuclear weapons development since the H-bomb. It is said to be highly effective in killing the enemy personnel but cause little damage to buildings and other structures. Also, there is no radioactive fallout.

From the information available so far, the neutron bomb is most likely a new type of small-sized hydrogen bomb. The conventional hydrogen bomb uses a moderate-sized uranium or plutonium fission device to trigger off the thermo-nuclear fusion reaction. This is necessary because the fusion of hydrogen nuclei needs extremely high temperatures, of the order of a few million degrees centigrade. And so far such temperatures could not be produced by chemical explosives like T.N.T. One result of using a uranium or plutonium trigger was that although hydrogen fusion itself does not produce much radio-activity, the bomb produced radio-active fallout due to fission debris. Besides, since the fission reaction needs a minimum quantity of the fissile material, the H-bomb could not be built smaller than a certain size. This posed problems of its delivery and deployment. These difficulties seem to have been overcome in the neutron bomb by using a non-fission type of trigger. While exact details are not known, it is likely that the trigger temperature is attained by using electromagnetic heating or high-power pulsed laser, or even shock waves.

Once the need of a critical size is done away with, the bomb can be built in any size, suitable for use in tactical warfare. It can then be carried by the ground troops also.

Since no fissile material is used, a neutron bomb does not produce any radioactive fallout. But it does give out intense bursts of high-energy neutrons and gamma rays which are lethal to any living being. But the low blast energy would cause little damage to buildings and structures. So it would be possible for the attacking force to occupy and use enemy territory in relative safety.

BIMAN BASU

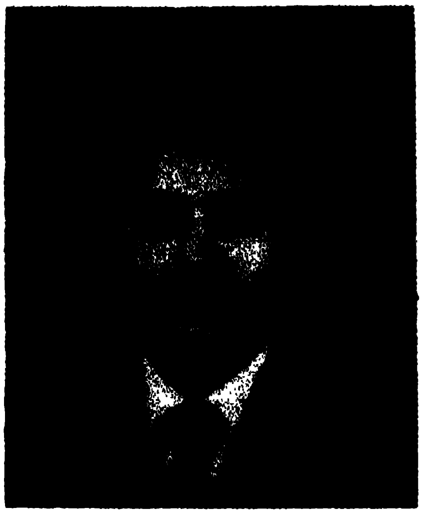
An Interview

Dr. K. Nagarajan

A few years back a brilliant physicist, having just returned from abroad, said in an article on educational system in India published in a leading daily that, "even our Ph.D. students are superficially interested in their subject". Is it a fault of our students or educational system? Most blame the latter. But after having listened to Dr. Kuppuswamy Nagarajan, the 1974 S. S. Bhatnagar Prize winner in chemical sciences, on this perennial problem, I felt there is a need to consider a third, yet un-cared-for factor.

It is the encouragement and patronage a teacher or researcher gives to his students. If the student-teacher relationship is informal, and a student is given free hand to indulge in his pursuits, and talented ones are spotted and given special attention and facilities, what could stop them from materialising into talented scientists? "Catch them young" is the phrase our scientists should remember. Dr. Nagarajan says that it is the ability of the American education system "to spot and encourage talent at an early stage of a student's career that contributes a lot to its success." He gave an illuminating example.

"In 1959-60 when I was at California Institute of Technology as a post-doctoral researcher in the tenth year of my career," he reminisced "an undergraduate was attached to my professor, J. D. Roberts, on a summer assignment. He was trained to use the sophisticated Nuclear Magnetic Resonance (NMR) spectrometer, and soon he not only mastered its electronics but also became proficient enough to grasp and wield its theoretical potentials. I am sure that he had a brilliant graduate and postgraduate career subsequently. Such patronage can go a long way in mobilizing young talent in our country." Dr. Nagarajan attributes his own successful career to the encouragement he got from his father and many teachers



Dr. Nagarajan

Born on September 15, 1930, at Sirupalai, Tamil Nadu, in the family of a school teacher, Dr. Nagarajan had a brilliant career since his childhood. He is one of the seven sons of the family, so his big family always lived off a shoe string budget. But for the assistance he received from Prof. K. Swaminathan, Professor of English at Presidency College, and the late Prof. K. Subrahmanyam, he "might have been forced to take up a clerical job." He took up the honours course in chemistry as it was then considered to be an "achievement". Later, on meeting Prof. T. R. Govindachari, of Presidency College, Madras, he decided to pursue research in organic chemistry at the same college.

Presently working as a group leader in Pharma Synthetic Chemistry Division of CIBA-GEIGY Research Centre, Bombay, Dr. Nagarajan is a Fellow of many national and foreign academies and associations. He has done research at many internationally renowned institutes and has 120 publications and several patents to his credit. His work is in the field of medicinal chemistry.

Dr. Nagarajan has synthesized a large number of new compounds, most of them heterocycles, for screening for antifertility, antiparasitic, antibacterial, antitubercular, antiviral and antidiabetic activities and also for effect on the cardiovascular and central nervous system. He developed a new and simple synthesis of dibenzoxazepine ring which helped the development of a clinically useful antidepressant.

Medical chemistry fascinates Dr. Nagarajan. It is a "satisfying" field for him as "positive results are capable of being of direct use in making of drugs". In fact he has played an important role in the elucidation of structures of several plants of medical importance. Also, he has been involved in the determination of the structure of the complex aminosugar nucleoside antibiotic, amicetin.

What part of his research work does he consider best? "Some of the applications of NMR Spectroscopy," Dr. Nagarajan replied, "that we carried out was intellectually stimulating and satisfying. This was not so much a matter of fluke as one of design. An important offshoot of this work was that we could obtain NMR evidence for the presence of allylic strain in some complex molecules. This strain concept had been propounded for cyclohexene in U.S. some years earlier. It was satisfying for us to have our NMR results confirmed by X-rays studies of Prof. G. Kartha."

To popularise science Dr. Nagarajan suggests that talks on various subjects be given to high school and undergraduate students by "people who practise science and live with it". In this way, he says, "the lectures will have a note of authencity and greater effectiveness than those given by their teachers."

Married to Padmalochana, a noted Bharathanatyam artiste and vocalist (karnatak music), Dr. Nagarajan has one daughter and one son.

DILIP M. SALWI

CORRIGENDUM

In Fig. 2, page 350 (*S.R.*, June 77), *read* 100 kilojoules *for* 100 kilograms

MEDICAL NOTES

Microwaves in medical service

THE use of microwaves in communication systems is well known. In developed countries research is in progress to exploit microwaves to solve energy problems. They have a role to play in medical and social needs of man as well

The electromagnetic fields in the spectrum between 1 MHz (1 mega hertz= 10^6 cycles per second), and 100 GHz (1 Giga hertz=10^9 cycles per second) are biologically significant They can be readily transmitted through, absorbed, and reflected at biological tissue boundaries in varying degrees These properties can produce medically beneficial effects or do biological damage. The frequency range in which people are most interested today is in the microwave spectrum of 300 MHz to 10,000 MHz Tissues of man in this frequency range have a good absorption properties

The idea of using microwaves for therapy originated in Germany in 1938 and 1939 when H. E. Holman discussed the possible application of radio waves of 25 cm wavelength for therapeutics. He predicted that these waves could be used to heat deep tissues without excessive heating of the skin. In 1939, A Hemingway and K.W Stenstrom, in the United States, suggested the use of higher frequency radiation for this purpose But during World War II, the biomedical research related with microwaves, to dispel the fears of possible ill effects of electromagnetic radiation upon personnel connected with radar work, gained more interest. As a consequence, a number of medical applications of microwaves have come to light.

Medical applications

The medical applications of microwaves can be classified into two areas : (1) therapeutic : heating of tissues, and (2) diagnostic. The former includes the most historic application, diathermy, and newer applications including rewarming of refrigerated whole blood, thawing of frozen human organs, production of differential hyperthermia (elevated body temperature) in cancer treatment, rapidly reversing a patient's hypothermic state (low body temperature) in open heart surgery, and the transmission of microwave pulses into nervous tissues for stimulating nerves. The latter may be used to block pain signals and also in some cases for the improvement of neuromuscular functions. Diagnostic applications include measurements to assess properties and conditions of certain biological tissues and to assess significant parameters such as blood volume and respiratory volume changes.

Diathermy

Diathermy is a technique used for providing therapeutic heating in tissues. Physical forms of energy such as ultrasound, electro-magnetic shortwaves, or microwaves are converted into heat after being transmitted to deep tissues and fatty layers beneath the skin. The beneficial effect of the diathermy in inflammation is that better heating leads to relief from pain. Figs 1 and 2 show shortwave diathermy application system and fields in layered human tissues. The applicators used with commercially available 2450 MHz diathermy apparatus are shown in Fig. 3. These applicators are basically a special type of antennae. Diathermy is now successfully used in the treatment of the diseases of muscles and bones, such as rheumatoid arthritis, fibrositis, myositis tendinitis The heating of tissue induces muscular relaxation, so it may be used for the relief from muscular spasm. Another advantage of microwave diathermy is that the patient is free to move away from the director and is free from pads, cables, and toweling commonly used in shortwave diathermy.

Fig. 1. Short-wave diathermy application with condenser pads to back with spacing between skin and electrodes provided by layers of terry cloth

Differential hyperthermia in cancer treatment

Research on application of microwave heating of body tissues for the treatment of cancer is now in progress in various laboratories of the world. Microwaves are used to heat the cancerous or tumour area

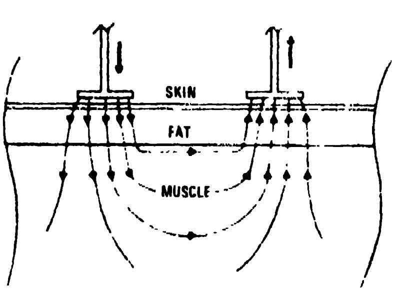


Fig. 2. Cross sectional sketch showing fields in layered tissue exposed to shortwave diathermy capacitor type electrodes

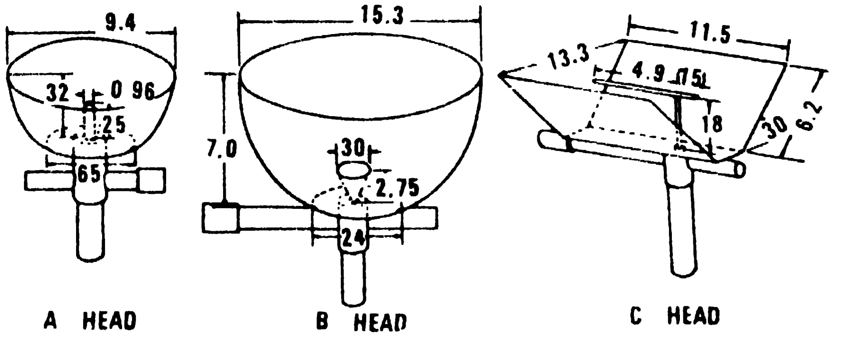


Fig. 3 Applicators used with commercially available 2450 MHz diathermy apparatus

selectively and uniformly at a very high temperature (hyperthermia) while the remainder of the body is maintained in a hypothermic condition (the temperature below normal body temperature) that is, 25° C below normal body temperature. A toxic anti-cancer drug is then administered to the subject. The cooler tissues absorb very little of the drug while the tumor absorbs a significant amount of it. Recent experiments on mice indicate that 75 per cent of the tumors disappear after 4 to 5 hours of treatment.

Warming of human blood

To prevent lowering of heat and body temperature below normal (hypothermia), the refrigerated bank blood is warmed from its 4°C-6°C storage temperature to body tempearture before introduction in the body. In the past, this was done by passing the blood through a long, small-core plastic tubing cooled in thermostatically controlled water bath. There is considerable resistance to blood offered by the heat exchanger which slows down the rate of transfer. It presents problems when rapid replacement is necessary. For a typical microwave blood warmer it takes hardly one minute to heat a unit of blood (approximately 500 ml) in its original plastic container from 4°C-6°C to 35°C. This warmed blood can then be rapidly administered to the patient. The unit is warmed by rotating it in a microwave cavity driven by a 2450 MHz 1000 watts magnetron. Extensive laboratory tests indicate no deleterious effect on the blood and its transfer to patient indicates no abnormal effects.

Rapid elimination of hypothermia

A standard technique used in open heart surgery is to reduce the body temperature to induce a hypothermic state prior to surgery. Hypothermia slows down the mechanism of metabolism (series of chemical changes in the living body to maintain life) so that nutrients and oxygen requirements are reduced sufficiently to allow the heart to be stopped for surgery. Surface cooling is desired before surgery as the peripheral body cells are cooled before the body temperature is reduced to the point when blood cannot provide nutrients and oxygen. For rewarming after surgery, core heating is desirable so that blood has sufficient temperature to allow proper metabolism prior to the rewarming of the peripheral cells. Peripheral cells require oxygen and nutrients at a level that the blood cannot provide due to the lower body core temperature. Core heating is possible in case of adults and large children by pumping blood through heat exchangers. This process takes along time and so restricts the total time required for surgery. Heating cannot be used in case of infants below a certain size due to the physical limitation of the apparatus. Microwaves offer a method to achieve core heating rapidly for a patient of any size by selectively heating certain portions of the body.

Rapid thawing of frozen tissues

It is known that an increase in the survival of biological materials

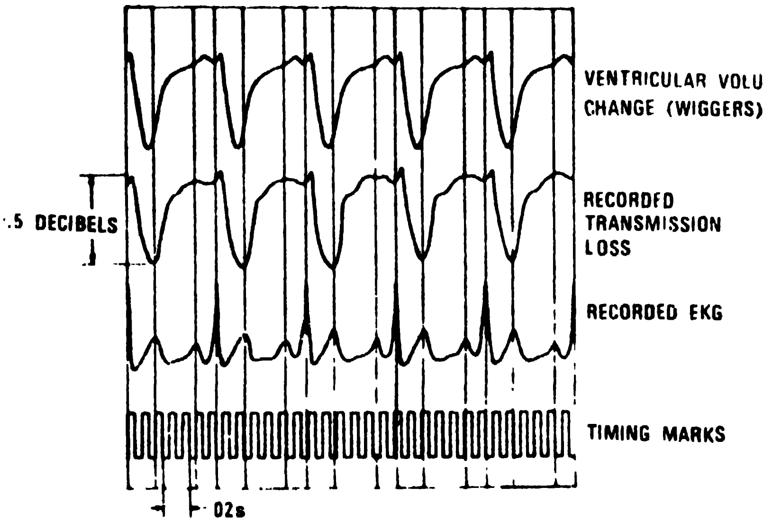


Fig. 4 Comparison of cardiac-ventricular volume change with recorded microwave transmission loss through chest cavity

is related with rapid thawing rates. Microwaves are capable of thawing human organs or other biomaterials such as semen. With proper development of microwave applicators, thawing rates upto 10 times faster than present can be achieved.

Diagnostic studies

In late 1960s Y E Moskalenko of U S. S. R. suggested methods for assessing changes in reflected and transmitted microwave energy which are caused by significant parameters such as blood or respiratory volume changes. Their feasibility has been confirmed by A. W Guy of U S A. by passing microwave beam through human chest. Fig. 4 illustrates that the variation of microwave loss is proportional to the ventricular volume changes in the heart. The potentialities of this approach appear favourable. Recently, J. C Lin of Wayne State University has also reported the use of microwaves in respiratory measurements.

It is true that microwaves produce severe ill-effects on human beings, but only when a man is exposed to high power microwaves. To avoid them however, safety standards should be observed.

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Sialin peptide may reduce tooth decay

A recent discovery by Dr. Israel Kleinberg of the State University at Stony Brook suggested a new and natural approach to the control and prevention of cavities. The discovery is based on a substance named sialin. Basically, sialin is a small peptide comprised of only a few amino acids. It is a component of saliva that counteracts the acid produced by the bacteria in the mouth, the cause of tooth decay. In fact, the substance is the body's mechanism to protect the teeth, but it is overwhelmed by an excess of sugar in the diet. Dr. Kleinberg, Chairman of the Department of Oral Biology of Dental Medicine, and coworkers have synthesized the substance in the laboratory so it could be commercially produced. Efforts are being made to find the most appropriate vehicle for raising the level of sialin in the saliva. The possibilities include a rinse, chewing gum, toothpaste or candies.

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BOOKS RECEIVED

1. **A DICTIONARY OF CHROMATOGRAPHY** by Ronald C. Denny *Macmillan Press Ltd.*, London, Representatives in India . 2/10, Ansari Road, New Delhi-110002, Pp. 191, £15.00
2. **A FIRST COURSE IN APPLIED ELECTRONICS** by W. Gosling. *Macmillan Press Ltd.*, (same as above), Pp. 162, Price not indicated
3. **TRIVENI Science, Democracy and Socialism** by A. Rahman. *Indian Institute of Advanced Study*, Simla-171005. Pp. 111, Rs. 22.50
4. **MICROBIAL AND MOLECULAR GENETICS** by J. R. Finchman. *Hodder & Stoughton*, London, Representative in India *BI Publications*, 359, Dr. D. N. Road, Bombay-400023, Pp. 150, Rs. 36 (£ 2.25)
5. **INTRODUCTION TO ECOLOGY** by R. Dajoz, *Hodder and Stoughton* (Same as above) Pp. 416, Rs. 71.20 (£ 4.25),
6. **MICROBIAL PLANT PATHOLOGY** by P. J. Whitney, *Hutchinson*, London, Representative in India · *BI Publications*, 359, Dr. D N Road Bombay. 400023. Pp. 160, Rs 47.20 (£ 2.95)
7. **BIOLOGY OF INSECTS** by C. P. Friedlander. *Hutchinson*, *London* (as above), Pp. 189. Rs. 47.20 (£ 2.95)
8. **FRESH WATER BIOLOGY** by L. G. Willoughby (same as above). Pp. 167, Rs. 47.20 (£ 2.95)
9. **PRINCIPLES OF CHEMISTRY** by A. N. Sharma and Y. P Jigyasu. *Kalyani Publishers*, Available at *Lyall Book Depot* Chaura Bazar. Ludhiana-141008, Pp. 783 Rs. 25.00
10. **THERMODYNAMICS** by J. N. Gurtu. *Pragati Prakashan*, P. B. No. 62, Meerut-1. Pp. 292, Rs. 14.50.
11. **ELECTROCHEMISTRY** by J.N. Gurutu. *Pragati Prakashan*, (same as above). Pp. 232, Rs. Rs. 12 60

SCIENCE FOR THE YOUNG

Chemistry creates a wonder world

LIFE as we know it would be strikingly different without chemistry. Chemists along with other scientists have made it possible for us to have conveniences and luxuries unknown to the kings a generation ago. The paper on which this magazine is printed, the permanent quick-drying ink used in its printing, the metal used in the type and the reproduction of illustrations are all the result of chemical processes.

An understanding of chemistry is essential in many professions. Whether you are a doctor, a grocer or a housewife--you have a chemist part also in you. A doctor uses lots of chemicals produced by chemists and a knowldege of their properties and physiological action is necessary for their judicious usage. Likewise, a housewife should not mistake sodium bicarbonate for common salt in her kitchen

In the laboratories chemists experiment with many materials, sometimes using complicated apparatus for producing a seemingly endless new products to satisfy our needs. Among these products are the sulpha drugs, penicillin, streptomycin, bakelite lucite, rayon, nylon, dacron and the silicones, to name a few.

You need not think that only great chemists can carry out chemical reactions You are also capable of doing complicated chemical reactions. When you strike a match, or boil potato, or wash your hands with soap and water, you are producing chemical changes Of course, you can clean your hands without being a chemist. But a bar of clean-smelling soap is a result of thousands of experiments by chemists

You can do other kinds of excellent chemistry This morning you combined calcium with carbon-dioxide to form calcium carbonate when you drank milk In other words, the milk has been changed into bone material in your body Similarly you may have separated proteins into amino acids to form other types of proteins when you ate an egg which is now on the way to becoming a part of your muscles

To most people, the label chemistry is largely associated with the production of somewhat simple chemicals - sulphuric acid, ammonia, ethylene, glycol and similar inorganic and organic chemicals.A much smaller number of people, when pressed, might add a few more materials that are also chemical such as plastics and resins, synthetic rubber and fibres, drugs, soaps and detergents, cosmetics and toiletries, paints and varnishes, and fertilisers and pesticides There are about a dozen categories of chemical and chemical products comprising the output of what is more formally known as the 'Chemical and allied products industry' At the same time, many other manufacturing industries that are not normally thought of as chemical have a considerable dependence on chemistry

Chemistry by definition deals with the molecular transformations that matter undergoes and, hence, the activities that occur in the industries dealing with ferrous and non-ferrous metals, petroleum, food, coal and coke, pulp and paper, stone, clay and glass, and electronic equipment should also be included in the treatment of chemistry.

Now, can you name a few objects you come across daily, which do not have a connection, either direct or indirect, with the chemist or his field of specialization ? You find it a tough job, because what all you say form the subject matter of chemistry. In fact, the universe, so to say, is the realm of chemists' activity. Such a view of the pervasiveness of chemistry is not offered with the thought of improperly aggrandizing chemistry beyond its limit. Chemistry is considered to embrace the practice of industrial chemistry and chemical engineering as well as chemical research and development and the academic preparations of professional manpower. Moreover, the practice of chemistry in industry reaches far beyond research and development into production, inspection and testing, sales and purchase and many other areas.

While emphasising the pervasiveness of chemistry, it has to be remembered that no scientific discipline is really independent of all others. Any given scientific or engineering talent must be complemented by other skills and many of the accomplishments of chemistry have resulted from the work performed by persons trained in other disciplines.

Chemists' accomplishments

All around you are the marvellous and useful works of chemists. Your food, your clothing and your home—just about everything you use—have been made possible by chemists. Chemists learnt to change wood into paper, and lumps of coal and grains of salt into white silky cloth. The storage battery in your car and the soap in your soap box contain important chemicals. Chemists also manufacture synthetic fibers, plastics, vitamin pills, foam-rubber, television tubes, coloured balloons, unbreakable records, solvents, dyes, cosmetics, paints, toothbrushes, detergents, insecticides and so on.

Methods and materials

It is very interesting to have a glimpse of a chemist's work and to see what methods and materials he uses. A chemist's materials are everywhere and in every thing. Everything in the world is of interest to him. He tries to understand what it is made of and how it can be used. Bit by bit, over hundreds of years chemists have found out more and more about the atoms and molecules as well as the elements and compounds of the world.

Chemists have always been puzzled at the changes matter undergoes under particular conditions. They are very much surprised at the formation of completely new materials with properties altogether different from those of the starting materials. For example, early chemists found that when sodium wire burns in chlorine gas, common salt is formed. Sodium is a highly reactive metal and chlorine is a poisonous gas. But their combination results in an entirely new and non-poisonous materials, finding an essential place in the kitchen.

Chemists call such changes chemical reactions. During a chemical reaction, a new product (common salt in this example) is formed when two or more materials (sodium and chlorine) react together. Chemists are not satisfied just by finding the use for the new product. They are interested more in understanding the way the change has taken place, and now we have a fairly good understanding of the mechanism of chemical changes; thanks to the accumulation of facts and principles by chemists over the years.

A chemist is curious about almost everything. One wants to know the chemistry of a rose, while another might be interested in a rotting waste material. There are millions of materials in the world—wood, plaster, clouds, water, salt, iron, clay, feathers—the list is endless. Is it possible to understand what each and every thing is made of, how they are useful and how they can be changed? The clue lies in the fact that molecules are made of smaller particles called atoms. Although there are millions of different kinds of molecules, there are only a few more than hundred different kinds of atoms. Each atom (also called an element) is carefully studied by scientists and is given a name—oxygen, hydrogen, silver, gold are a few of them.

But then, most of the things we know are not simple elements but combinations of elements. Common salt is a combination of sodium and chlorine, while water contains hydrogen and oxygen. Such combinations are called compounds. A compound is quite different in its properties from the elements of which it is made, as is seen in the case of common salt. Another example of a compound is sugar. It is made of carbon, a black solid and hydrogen and oxygen which are gases. None of the three elements is either white or sweet as sugar.

Chemists imitate nature

Nature has a fantastic skill to produce things. Look at the array of beautiful colours of the fruits and flowers in your garden. The plants and trees could produce these things with the water and manure you give them, with the help of sunlight. When Wöhler (a German scientist) made an organic compound from an inorganic raw material in 1823, the idea that only living things could produce organic substances through life processes was proved false. You will wonder that some of the greatest advances in science have come from the elimination of false ideas and theories and Wöhler's discovery is an excellent example. It led to attempts to make other known organic substances. Many of these efforts were successful. One synthesis led to others and now snythetists can prepare many of the naturally occurring materials.

Nature does not always provide man with pure substances. Mostly they are mixtures and often the components have to be separated before use for effective applications. Certain preparations made from plants, like poppies and coca, have long been known to kill pain when ingested by human beings The plants contain the pain-killing substances morphine and cocaine along with several other substances. With the passage of time, chemists learnt to isolate these substances from plants. Thus, one of the tasks of chemists is to investigate the molecular composition of such naturally occurring mixtures and separate them into pure substances. Analysts and analytical chemists do such job. Modern analytical and separation chemistry has advanced so much that even the most difficult analysis/separation can be carried out within a reasonably short time.

When organic chemists realized the importance and usefulness of natural products like wood, petroleum and coal, they tried to understand how the molecules of these products are constructed. After many years of painstaking research, they realized that the molecules of all natural organic materials that are strong, elastic, insoluble and melt at high temperatures have one essential feature in common—giant size. The giant molecules are composed of large numbers of smaller units connected end-to-end like coaches in a train. For example, each molecule of cellulose (the substance that gives rigidity and strength to plants) is made of strings of glucose molecules and each molecule of natural rubber is made of strings of isoprene units. The simple units are called monomers while the strings of monomers are called polymers. The way the monomers are connected to form the chain-like polymer decides the properties of the polymer—whether it will be flexible like rubber or rigid like plastics and textile fibers.

Chemists excell nature

It is one thing to use materials readymade in nature. But it is quite different to design and build special materials in the laboratory. Thus, a chemist's main task lies in the production of new substances not found in nature or occurring rarely. The knowledge gained by polymer chemists about the structures and properties of polymers has enabled them to design new molecules that would behave just as they wanted them to. We now have a variety of synthetic fibers, plastics and rubbers, each with properties the chemist intended it to have.

Polyethylene is a familiar man-made polymer. Squeeze bottles, toys, water pipes, food wrapping and electrical insulation are only a few of its applications. Likewise, butyl-rubber is an important synthetic rubber. Being much superior to natural rubber, it is widely used for automobile inner tubes. Fibers like nylon, rubbers like butyl rubber and plastics like polyethylene are only a few of the interesting and useful polymers that chemists have discovered.

There was a rapid progress in the manufacture of new substances in 19th century and the trend towards substituting man-made materials for natural ones is on the increase. Nowadays chemistry provides us with shoes and clothing and the time is not far off when it will start replacing the natural foods with the synthetics from petroleum products. A layman might be sceptical of such an idea. But a simple example might remove all his doubts. Which do you think would make a better perfume, lilies of the valley or a lump of coal. The answer is coal. It is very difficult to extract the essence of the flower because it is very delicate, but chemists could produce from coal a fine perfume with the scent of the flower. Other perfumes like Jasmine scent is prepared from phenylethyl alcohol and musk from xylene. These perfumes can also be derived from coal

There has been considerable progress in the synthesis of food products. As a result, synthetic chemical compounds have found application in natural foodstuffs to give them attractive appearance, consistency, smell and taste. In addition, certain vitamins and aminoacids are synthesized commercially. It will not be long before synthetic proteins, fats and carbohydrates become competitive with natural products if the chemists find out simple and economic processes for their synthesis.

Think for a moment of photosynthesis, the process by which water and carbon dioxide combine in a green plant to form sugar. If this can be carried out artificially on a large scale, we shall be able to set up factories to mass produce food. This would be possible when chemists thoroughly understand the mechanism of photosynthesis.

Consider the problems of human or plant diseases. The way in which a medicine (a drug or a pesticide) works depends on the structure of its molecules. As the connection between molecular structures of living things and their function becomes better known, we shall be able to make better drugs, fertilisers and pesticides. Scientists are now trying to understand and imitate the giant polymers in plants and animals. Future developments in health care and agricultural production are closely connected with the development in understanding the chemistry of life. We have seen chemists successfully developing superior grade materials (like artificial rubber and synthetic fibers) which nature would envy. One day chemists might be successful in synthesizing a superior race of human beings!

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Your nose knows more than you know

A mother knows the smell of her own baby so well that even blindfolded she can pick it out of a nursery full of infants. The baby, in turn, knows the smell of its mother and probably, its father. Wives, however, cannot distinguish the smell of their husbands' hair from that of an old dachschund!

Dr. Orville Chapman of the University of California, Los Angeles, became interested in odour perception while working with a student entomologist. Together they discovered that insects and other species communicate with each other via chemicals called pheromones. For insects, pheromones not only constitute an odour language, but it is their best way of obtaining information about the outside world. Other animals rely less heavily on their sense of smell, with dogs about one million times less sensitive than insects, and man, at the lowest end of the scale, a million times less sensitive than dogs. Even with reduction, odour perception is operating all the time at a subconscious level, evoking an emotional reaction rather than an idea as sight does. The olfactory nerve is connected with the most primitive part of the brain; the message it sends—unlike a visual signal—is not filtered through the intellect. Communication from a skunk, for instance, is direct and persuasive. It is not something to mull over. Think of new-mown hay, and sight-smell, and touch-memory are all experienced at once.

Memories evoked

Deja vu, the sudden feeling of familiarity in an unfamiliar place, is believed to be the result of an unperceived odour evoking an old memory. If this is so, psychiatrists could capitalize on it by using odours to unlock a patient's blocked memories. In addition, an odour which suggested peace and security might be used to relieve anxiety. The odour of breast milk, the first smell associated with falling asleep, might develop into a replacement for sleeping pills.

Among most animals, a certain pheromone in a particular strength must be present before mating can take place. The implications of this in human terms are sensational. A drop of human aphrodisiac pheromone, would ensure the continuation of the human species. It is certain that humans are attracted to each other, even now, for unexplained reasons, some just sensed. It is known that perspiration from physical exertion is inoffensive and probably has an aphrodisiacal effect. Perspiration produced by tension, however, is always immediately offensive.

Link with immune system

"There is something here no one understands, and I have some reservations about understanding it." Dr. Chapman says cautiously. Within the body, he believes, the immune system communicates by chemicals shaped like the pheromones of odour language. Small fat molecules—lipids—control the function of certain organs and systems. The ratio of these lipids may be each person's chemical fingerprints—his identity—or the balance that his immune system seeks to maintain. When a foreign substance upsets this characteristic balance, the immune system gathers to fight it, often, scientists believe, destroying early tumours before they are medically recognizable.

What attracts the immune system to the tumour and what turns the tide, causing the body to accept and allow a tumour to grow to lethal proportions, is something worth investigating. It is probably the lipids shaped like and structurally related to the pheromones of odour language.

From memories of fresh hay to the body's immunity, it is plain that odours play a subtle and important part in our lives. Just how important, scientists are only beginning to recognize.

"Those volatile lipids, those pheromones, may manipulate us in any number of ways—from curing cancer to explaining that funny thing called love."

DR. R. RAGHUNATHAN
Nashville, Tennessy, USA

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Do it at home

Inexpensive fire alarm

HERE is a project that is both simple and inexpensive. It costs less than Rs. 20 and is easy to construct. The entire project can be built in an hour.

The thermistor

The thermistor is a small slab of semiconductor whose resistance decreases as the temperature of the semiconductor slab increases. When the thermistor is heated the number of charge carriers increases, thus decreasing the overall resistence, and, as a result the current through it increases.

How it works

Look at the circuit (Fig. 1) and imagine the thermistor (T) removed and the gap bridged by a wire. This is the configuration of an oscillator, a circuit which will produce an audible tone in the speaker (S). With the cold thermistor wired in, the base bias falls below the minimum required for oscillation. However, when the thermistor becomes warm, its resistance drops sufficiently and the required value of base bias is established. This starts oscillations and the alarm tone is heard in the speaker. Unlike circuits using relays, this circuit does not have the disadvantage of requiring resetting after having tripped once. However, relays could be used to trigger visual alarms or other electronic alarm circuits.

Components

Transistor(TN)—AC128....1 no.
Capacitors C_1—0.1 mfd 16 wvdc
C_2—0.22 mfd 16 wvdc
Potentiometer(X)—500 K ohm log 1 watt
Thermistor(T)—DLZ100 or DLY100
Transformer—Output, matching AC 128 to 8 ohm load
Speaker(S)—8 ohms, PM, any normal size.
Battery—9 volt

Construction hints

The components can be easily mounted on a 5-tag board. Keep the transistor(TN) cool using a heat sink. In continuous operation the transistor warms up. Any small metal sheet tightly clipped to the can of the transistor will do.

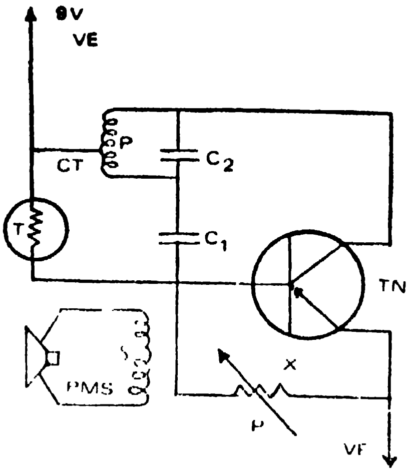

Fig. 1

Testing

Check connections and battery polarity. Adjust the potentiometer for maximum resistance and decrease it slowly keeping the thermistor at the temperature at which the alarm should sound. Stop as soon as the tone is loud enough to be heard. Cool the thermistor, the tone should disappear. Now check if the circuit is working correctly by taking the thermistor to a source of heat. The alarm should sound.

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Clues (*Continued from page 537*)

tion; used for culinary (pertaining to cookery) purposes also.

2. A herbaceous twiner (*Papilionaceae*) with white and blue flowers. Action: laxative and diuretic.
3. An annual herb (*Umbelliferae*). Its fruit or its volatile essential oil content is carminative, diuretic and stimulant; used for culinary purposes also.
4. An annual or perennial herb or shrub (*Solanaceae*). Its fruit, yielding a pungent principle, acts as local irritant and general stimulant; used in curries and pickling.
5. An annual herb (*Umbelliferae*) whose fruit, yielding an essential oil, is carminative and stimulant; used as a condiment.
6. An annual herb (*Urticaceae*). Flowers or fruit tops are used for their resin content. Action; intoxicating and sedative.
7. A large shrub (*Asclepiadaceae*) whose roots, leaves and flowers are used. Action is on the heart. A digestive.
8. A tree (*Rubiaceae*). Dried bark is used. Its alkaloid is used in the treatment of malaria.

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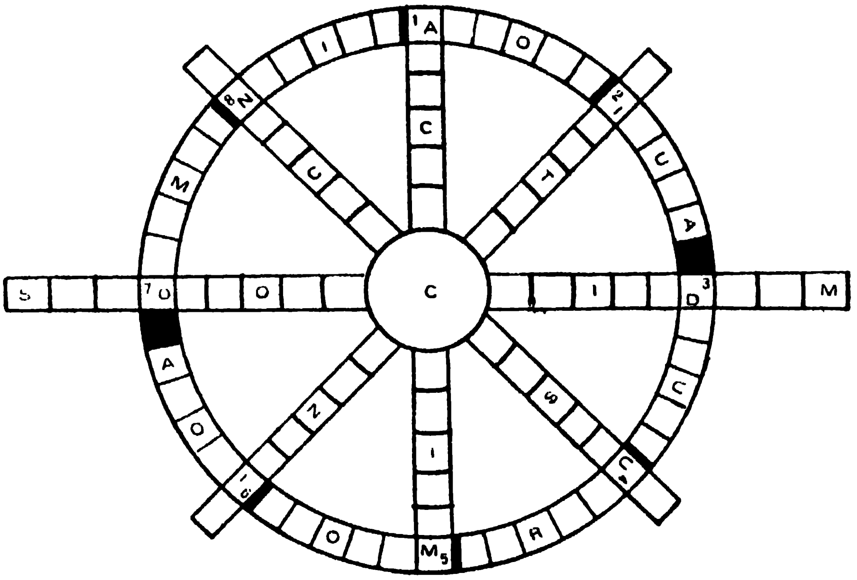
Science Wheelword Puzzle (Medicinal plants)



NOTE: The reader is required to fill in the botanical name (generic name) of the conncerned medicinal plant.

CLUES

The rim (Clockwise)

1. A herb (*Solanaceae*) whose dried leaves and tops are used to extract an alkaloid having mydriatic (abnormal dilation of the pupil) action.
2. A herb (*Compositae*) known for its essential oil and bitter principle content of the rhizome and roots.
3. The dried leaves and flowering tops of this herb (*Solanaceae*) are used for their naroctic and antispasmodic action.
4. A shurb (*Anonaceae*) which yields a sweet, scented essential oil from its roots.
5. A sensitive shrub (*Leguminoseae*) whose roots and leaves exhibit carminative and resolvent action.
6. Roots and flowers of this shrub (*Rubiaceae*) are sedative in action and are stomachic tonic.
7. A strongly scented herb (*Labiatae*). Its shoot possesses carminative and stimulant effect.
8. A shrub (*Apocynaceae*) whose roots (bitter principles) and leaves (an alkaloid) are medicinally important. The root extract is diuretic and a cardiac tonic.

The spokes (names begin from centre, C)

1. A herb (*Zingiberaceae*) with tuberous root stocks. Tubers and rhizomes are used for carminative and stimulant ac-

(*Continued on page 536*)

Crossword Puzzle (Solved)

1 C	R	2 Y	O	3 G	E	4 N	I	C	S	■	■	5 B	■	■
O	■	A	■	H	■	I	■	■	■	6 C	R	E	E	7 P
8 H	Y	G	R	O	S	C	O	9 P	E	■	■	T	■	O
E	■	I	■	S	■	O	■	I	■	■	10 H	A	L	L
R	■	■	11 E	T	A	L	O	N	■	■	A	■	■	A
12 E	H	13 F	■	S	■	■	■	C	■	14 O	L	B	E	R
N	■	E	■	■	15 R	■	16 M	H	17 D	■	O	■	■	O
18 T	O	R	Q	U	E	■	E	■	I	■	■	19 C	■	I
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21 Q	■	22 I	S	23 O	T	R	O	P	I	24 C	■	R	■	■
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32 K	E	R	R	■	V	■	33 L	E	P	T	O	N	■	T
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Solution to crossword puzzle published in July 1977 issue

FOR HER

Diets - do's and dont's

OUR eating habits have changed drastically since the beginning of the century, when carbohydrates (sugars and starches) were the main source of food energy. Sugar has replaced complex carbohydrates - fruits, vegetables and whole grains - in popularity, mainly because people started consuming large amounts of soft drinks. This increased use of sugar may have some serious consequences. The most immediate effect is that sugar, offering little nutritional value, is replacing foods high in nutrients. Not only does this deprive the body of nutrients. According to a report published in the U.S.A, sugar calories may increase the body's requirement for certain vitamins. Sugar also has been implicated in the incidence of diabetes in genetically susceptible persons and in widespread tooth decay. Although sugar now contributes about 40 per cent of the calories in the average American diet, the report recommends cutting sugar intake down to 15 per cent by eliminating soft drinks and baked foods while using more fruits and vegetables.

The increased consumption of whole grains may have several good results; it may reduce the risk of heart disease by lowering the levels of fat and cholesterol in the blood; it may help treat diabetes; it may provide more natural fiber to the diet, which some researchers believe will reduce the incidence of colon cancer and other diseases; and it will supply vitamins, minerals and micronutrients. Weight watchers will be glad to know that eating more carbohydrates may help make weight control easier by displacing fats and sugars. Also, the high water content and bulk of fruits and vegetables and the bulk of the whole grains may satisfy appetites more quickly than do foods high in fats and sugars. To increase carbohydrate consumption to the recommended 55 to 60 per cent of daily calories, the report advises eating home-grown produce or equal amounts of store-bought fresh and frozen food. Potatoes and green leafy vegetables contribute good amounts of nutrients and fiber. Highly processed foods should be avoided. The less processed whole wheat bread contains more nutrients and fiber than white bread. Instant rice suffers considerably in processing, while brown rice provides the best nutrition.

Another unhealthy habit is the overconsumption of fat, especially saturated (animal) fat. If on average 40% of the daily calories are obtained from fats, obesity and its attendant risks of heart disease, high blood pressure and diabetes may develop. Some studies have suggested a correlation between dietary fat intake and the incidence of breast and colon cancer. Fat intake should be reduced to about 30% of the daily calories, with saturated fats accounting for 10%. Saturated fats are a cause for concern because some studies have linked them to excessive levels of cholesterol in the blood and ultimately to heart disease. There is some evidence too, that direct intake of cholesterol increases the level of cholesterol in the blood. Experts recommend limiting cholesterol to about 300 milligrams per day (one egg contains about 250 milligrams). By eating more vegetable proteins such as legumes and more fish and poultry instead of red meats, cholesterol levels and saturated fat intake can be reduced.

The final recommendation, to reduce salt consumption, is based on evidences indicating that salt increases blood pressure in some individuals. An estimated 20% of the population, including children, is susceptible to high blood pressure. Some studies have indicated possible connections between a high salt intake and heart disease, stomach cancer and migraine headaches. The goal of three grams of salt a day is equal to about three-fifths of a teaspoon, which can be met without adding any salt to food.

How did people develop their poor eating habits? The report mentions several factors: One is that rise in incomes has permitted consumers to buy more expensive foods instead of the greens vegetable proteins and whole grains they once bought to economize. Another is that insufficient nutrition information is included on the labels of food they buy. Food labels rarely, if ever, indicate the type of fats and oils added or the percentage of sugar, salt and other additives included. Advertising receives much of the blame for the unhealthy state of nutrition. In order to make us mend our unhealthy ways, the report recommends a public education program in nutrition and extensive nutrition labeling including the type of fats, plus the percentage of sugar, salt, cholesterol, additive and calories in products.

The risks associated with eating this diet are demonstrably large. The question is not why should we change our diet, but why not? What are the risks associated with eating less meat, less fat, less saturated, fat, less cholesterol, less sugar less salt, and more fruits, vegetables, unsaturated fat and cereal products especially whole grain cereals? There are none that can be identified and important benefit can be expected. Then why not change? The sooner the better!

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Rat cancer correlated to cosmetics

RESEARCH sponsored by the National Science Foundation of the U.S.A. has shown that many popular shampoos, lotions and cosmetics contain a compound which cause cancer when fed to rats, according to a group of chemists who presented their report at the American Chemical Society convention, recently held at New Orleans. It is not possible at the present time to assess properly the potential hazard to man.

The researchers pointed out that studies on the cancer-causing compound involved ingestion, and not just putting it on the skin. The group of six scientists, all from Massachusetts, said they tested popular cosmetics bought over the counter at stores around Boston and found that many contained a compound known as N-nitrosodiethanolamine, or NDEIA. They cited other studies which have shown that NDEIA caused liver cancer in rats that ate it. They said that since the cosmetics contained a superwetting agent, triethanolamine, it does not seem unreasonable to assume that a significant amount of NDEIA applied to the skin may be absorbed, thereby causing cancer ultimately.

R. RAGHUNATHAN

A single drink could damage a child's brain

ALCOHOL in quantities as small as one mixed drink can cause irreversible brain damage or retardation in young children, according to Dr. Will Alemeir. Alcohol is a special danger to children because it tends to cause hypoglycemia, which is a drop in blood sugar. The brain needs blood sugar to function, so if blood sugar drops for long enough, brain damage or retardation can occur.

Alcohol should be considered a poison where children are around. A four year old boy was taken to emergency, after accidental uptake of a small amount of wine. The child was at once woozy and then had convulsions. Pediatricians checked the child's blood sugar content and it was 10, the usual range being near 70 . The child was immediately given glucose intravenously, which is the treatment for hypoglycemia and within minutes the child woke up and next morning he was fine. Of each of the 6-8 cases reported to have drunk alcohol for one reason or other, 2-3 had a drop in blood sugar. Very small amounts of alcohol makes a child vulnerable to hypoglycemia. But children under the age of 10 would be most seriously affected; just one can of beer could affect the intelligence and motor areas of the body.

Parents may not know how dangerous hypoglycemia is. The child does not have to drink alcohol to have this condition. Just one occasion of very low blood sugar can cause permanent damage unless the child receives medical attention in an hour or two. Early signs of a drop in blood sugar are anxiousness sweating and nervousness. Without any treatment unconciousness or seizures might develop. An old home remedy for bringing down fever the use of alcohol is being questioned by doctors. Some people sponge off feverous children with alcohol and water. If this is done in a small closed room the child could breathe enough fumes to cause hypoglycemia. If the child was on other medication, the intake of alcohol could be twice as dangerous. Many doctors now agree that alcohol should be kept far away from the reach of children.

R. RAGHUNATHAN

Science in Industry

Dental amalgam alloy

THE National Metallurgical Laboratory (NML), Jamshedpur, has developed a process for the production of a dental amalgam alloy for filling up the cavity of decayed teeth. The estimated demand for this alloy is 4000 to 5000 kg per year and this is met partly by imports.

In the NML process, raw materials in the purest form are melted in a furnace, and the melt is stirred thoroughly before pouring. Pouring is done in mould. The ingot is then homogenized, processed for obtaining proper particle size followed by suitable heat-treatment. All the raw materials required are available indigenously.

The main equipment required are: melting furnace, crucible, ingot moulds, shaping machine, annealing furnace, and cold flat rolling mill. All the equipment, except for cold flat rolling mill, are available indigenously.

Laboratory-scale investigations have been completed. A successful clinical service trial was conducted at the Tata Main Hospital.

The material was tested as per the standard specification and was found to conform fully to IS: 4704-1968, BS : 2938-1957 and to that of the American Dental Association, 1934.

The suggested capacity of an economic unit is 3000 kg of alloy per year. The estimated capital investment for such a plant (based on 2 shift operations in a day and with 300 working days in a year) is Rs. 13.35 lakh, and the cost of production per kilogram is about Rs. 1400.

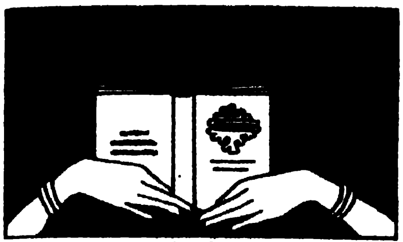
Portland cement coating for steel

THE Central Electrochemical Research Institute (CECRI), Karaikudi, has developed a protective coating based on portland cement which provides good protection to structural steel in a salt-laden atmosphere. The coating provides, in particular, adequate protection to steel reinforcement rods both during storage at site and when embedded in concrete and helps increase the durability of the reinforced concrete structures exposed to corrosive atmospheres. The specific advantage of this coating is that it does not adversely affect the bonding between steel and concrete. Large-scale trial and demonstration has shown that the coating procedure is quite feasible under field conditions.

Besides on reinforcement rods, the coating finds useful and cheap application on steel sheets (corrugated), angles, poles and pipes. Compared to organic coatings, this coating is cheaper.

Portland cement, inhibitor solution and water glass are the main raw materials required for the manufacture of the coating, and all these are available indigenously.

The total investment for setting up a plant capable of producing the coating for protection of 1000 tonnes of steel reinforcement rods is estimated at Rs. 80,000 (comprising Rs. 30,000 as fixed capital on plant and Rs. 50,000 as working capital).



BOOK REVIEWS

EARLY SOLAR PHYSICS by A. J. Meadows, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 312, $ 13.

HOW ideas evolve is an interesting subject in itself. The process is similar to evolution of species but on a smaller time scale. Every scientist who adds something to existing knowledge thinks he has taken a "big step ahead" but when seen as a whole his work seems a drop in the ocean. Only the invention of a tool or discovery of an effect are the major milestones which, like mutations in a species, bring revolutionary changes in the evolution of a subject. The story told of how a subject evolved, therefore, not only is an experience for a researcher in the field to take to heart but also could prove to be an amusing story of interest to any scientist or for that matter a layman. There are, however, a few books of this type and the book under review is one among them. It deals with solar physics.

Why the need for such a book on solar physics? The author doesn't say anything except that to "provide some insight into the changes and developments" in the subject. In the opinion of this reviewer it is to teach astronomers and astrophysicists some 'lessons'--for which, in fact, history is meant. For instance, the history of development of solar physics, as narrated in this book, tells how once highly accepted theories had in time met their death. Could it be possible that what today we take for granted, for instance, that sun produces its energy due to thermonuclear reactions, would turn out to be absurd tomorrow? The present controversial theory that the sun is generating so much energy due to a black hole it contains might be an accepted theory tomorrow. All this is possible. Likewise, the entire subject of astronomy and astrophysics might one day need overhauling due to a fundamental discovery or invention. In short, one should not take anything for granted or only accept the prevailing "fashionable" beliefs. Indeed, such a book is a welcome for researchers of as mysterious a subject as the universe.

The book is divided into two parts: the first deals with the historic development of ideas and the second is a list of noteworthy papers which duly figure in the part I. Starting with very silly ideas the early astronomers had when interest about sun had just been created, the book covers the development of ideas only till the beginning of the present century. The emphasis is on the period 1850 to 1900, called new astronomy by the author, in which solar spectroscopy brought revolutionary changes in the understanding of sun. The next turn was, according to the author, the coming of 'New Era in solar physics' which began when in 1913 Neil Bohr proposed a workable theory of atomic spectra. Here, with some discussion the historical part ends. Suiting to the title, this much history seems enough, though with the discovery of radio sun in 1942 a new chapter has begun in the further understanding of solar physics.

This historical account in Part I, besides giving the dialogues of scientists wherever necessary to emphasize a discovery, also gives author's interpretation of why a particular scientist, because of the milieu he was in, thought or argued as he did. The papers reproduced in Part II not only tell the difference between how they were written then and now but also will teach a budding researcher how to forward to one's arguments. The book is otherwise a scholarly work and is meant for researchers or those who wish to acquire the bent of mind needed · in research. To be frank, a layman would not find anything of his interest in this book notwithstanding the fact that it is written in a simple and easily understandable manner. This is mainly because of two reasons. First, it doesn't contain any sparkle of amusement or thrill; the treatment is rather heavy. Secondly, why should he be interested in old concepts when to know the latest in science is his aim?

DILIP M. SALWI

HUMAN POPULATIONS by David Hay, *Penguin Books Ltd.*, England, Indian Representative: *Penguin Overseas Ltd*, 706, Eros Apartment, 56, Nehru Place, New Delhi-110024, Pp 96, £ 2.75.

HUMAN population continues to be a topic of discussions, writings, debates, conferences, symposia and what have you! Which is as it should be. Man has realized as never before that his survival is being threatened by the multiplication of his own species.

In about 900 years from now, if the present rate of growth of human population continues, the entire land and sea will be covered by a continuous 2000 storey building to house every man. And 900 years is not far away. Already there are countries which are groaning under the weight of bulging human populations. Bangladesh, South East Asia and China are examples. Why the human population is growing fast, the social and economic factors 'contributing to it and the present state of human communities in different parts of the globe are pictorially summarized in this fascinating little book. It is good for those who wish to know the basic data about the human population in the world today.

If you are looking for a serious scientific and incisive discussion on this menacing problem you will perhaps be disappointed. In many ways the book is superficial. For instance, it attempts to answer the question why mainly the oriental countries show bigger human populations than the western countries. This question needs to be investigated by physiologists, geneticists, endocrinologists and ecologists to provide a reasonably plausible answer. However here it is discussed in just one or two pages, and that also casually. Besides, it is wrong to say that the birth rates in eastern countries are higher than those in the western countries. In the USA the birth rate is perhaps much higher than in many countries in the east.

One reason of low density of human population in western hemisphere is that the countries there have fought terrible wars among themselves. These wars in the past 200 years have caused depletion of their human population. In contrast, eastern countries have lived in peace with the result that there was no marked deletion of human population.

This book does not describe at all the recent achievements in the development of contraceptive devices to check population. It also does not mention the national effort being made in India and other eastern countries to control their population.

NUCLEAR POWER by Walter C. Patterson, ***Penguin Books***, (same as above) Pp. 304, £ 0.80.

ABOUT two decades ago, when the first commercial power reactors went into operation, nuclear energy promised limitless amounts of cheap, clean electric power. Today more than 190 nuclear power reactors are in operation in over 20 countries and according to present estimates there will be at least 600 of them by 1985. But of late there has been much controversy over the safety of nuclear power. In many countries, especially the United States and Europe, a fierce debate is going on over the benefits of nuclear power and the potential risks.

A nuclear power plant is no doubt clean; at least apparently cleaner than the fossil fuel burning plants. It is more convenient to run—once fuelled it can operate for months at a stretch. But it uses a fuel which being radioactive is by itself highly dangerous, and the waste products are equally so. It is this factor that has brought nuclear plants under increasing attack. Critics feel that the existing safety measures are not adequate. But its proponents hold a different view. And in this battle of opinions the common man is totally confused.

Nuclear Power discusses these and many related issues. It covers all aspects of the subject, factually. In lucid details (with diagrams and tables) the author tells us about the various types (there are no less than eight of them) of power reactors; about their advantages and disadvantages; about the various forms of fuel preparations and methods of waste disposal.

The book's ten chapters are divided into two parts. Three chapters comprising the first part deal mainly with technical matters like nuclear fission, design of reactors, fabrication of fuel elements and disposal of wastes. The second part is more elaborate. It begins with the discovery of radioactivity by Henry Becquerel and then goes on to the first atom bomb, radioactive fallout, and the subsequent developments. Here we come across the first public protests against the bomb, and also the dubious attempts by the authorities to suppress the truth about the tragic effects of nuclear fallout.

Nuclear electric power first became available in the early 50's. At that time few realised the potential risks of nuclear power plants. Yet the first mishaps occurred within a few months, releasing radioactive gases into the atmosphere. By the end of the 60's there had been no less than half a dozen major reactor accidents in Canada, U.K., the U.S.A., and Switzerland. Three lives had been lost.

Accidents are not the only possible threat from reactors. Today's reactors are built with several safeguards against them. What is more worrying is that they produce highly fissile and toxic plutonium. The chemical toxicity of plutonium is so high that even in traces it is fatal to man. From the strategic point of view, being a fissile material, plutonium can be used to make weapons. (Incidentally, the author cites the Indian nuclear explosion of 18 May 1974 in this context),

The biggest problem with nuclear reactors, even if used only for peaceful purposes, is the dangerous radioactive wastes they produce. Normally after a certain period the nuclear fuel in a reactor—natural or enriched uranium or its oxides—is taken out for 'reprocessing'. While inside the reactor core, the uranium gets converted into plutonium and a large number of highly radioactive elements. Some of these have a tendency to capture neutrons which hamper the chain reation. So even before the uranium-235 in the fuel gets completely depleted it has to be taken out. The used fuel rods are chopped, crushed and dissolved in nitric acid. Uranium and plutonium are separated from the solution by extraction with organic solvents. After that the highly corrosive and radioactive liquid—millions of litres of it—is simply dumped in underground storage tanks. No other effective way has been found so far for their safe disposal as many of the elements in the waste have half lives of tens of thousands of years. As a result, more of these highly radioactive liquids are getting accumulated all over the world. And there have been cases of tank leakage resulting in the seepage of radioactive liquid into the ground.

All these are serious problems and there cannot be simple solutions. With the rapid progress of technology many of them will be solved in the near future. But there is no point in convincing the public that they do not exist. It is in this context that Patterson's book will provide the inside story of the whole nuclear business. But the author admits, that this is only one man's viewpoint. He says, in nuclear matters, never take any one viewpoint as gospel---including the present one!

BIMAN BASU

ELEMENTS OF GROUP THEORY FOR PHYSICISTS by A. W. Joshi, *Wiley Eastern Ltd.*, AB 8, Safdarjung Enclave, New Delhi-16 2nd Edition, (1976), Pp. 324, Rs 45.00.

AS the title indicates, the book under review deals with the elements of the group theory and its application to some problems of physics. In recent years, group theory has found increasing applications in solving various important problems in physics and is now an indispensable tool to research workers engaged in understanding the basic phenomena of nature. Group theory has not yet found its due place in most Indian universities' M.Sc. (Physics) syllabi. So fresh research students find it hard to cover the gap so created. To add to their problems, the required topics are not covered by any single book. This book is a successful attempt to solve this aspect of the problem.

The first two chapters of the book are introductory in nature and give a clear picture of group theory, vector spaces and operators. Various terminologies and mathematical topics relevant to the study of the subject form the subject matter of these chapters. The next two chapters deal with theory of finite and continuous groups. Remaining chapters have been devoted to various important applications of group theory in quantum mechanics, atomic physics and solid state physics. In the end there are appendices discussing interesting topics like elastic constants of crystals, piezoelectricity and dielectric susceptibility, and time reversal and degeneracy. After every chapter, a large number of good problems have been given. Similarly every chapter is followed by a bibliography which will undoubtedly be useful to those who want to study the subject further.

However, inclusion of a few more topics would have added to its value. They include definition of terms like semi-simple subgroup, simple subgroups, algebra, etc. Also the definition of field in chapter 2 is not complete. It should include the property that operation multiplication is distributive over the operation addition. Similarly, a list of abbrevations and symbols used should have been given separately.

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MAIN TOPICS IN ANIMAL TAXONOMY by Ram Prakash Sethi, *Rajhans Prakashan Mandir* Meerut, Pp. 225, Rs. 14.00

ELEMENTARY BIOCHEMISTRY by Singh, Garg and Goyal *Nem Chand and Bros.*, Roorkee, Pp. 145, Rs. 6.25

TEXT-BOOKS in biological sciences used so far in our universities have become obsolete not only because of the changed syllabi but also because of the fact that the tremendous amount of interdisciplinary research done in the field of life sciences over the past four decades have modified considerably the basic concepts of biology.

'Main Topics in Animal Taxonomy' has very succinctly organised entire syllabus to bring out the importance of the subject in the light of recent developments in the fields of palaeontology, biochemistry, molecular biology, etc. What is most commendable is the way in which authorities in the field, like Simpson, Mayr, Cain and Blackwelder have been referred to at every step and their definitions quoted. This approach has gone a long way in maintaining the academic standard of the book. Also, it introduces the students to the classics on the subject. Controversial debates in the field have been dealt with rather well; the discussssion of the 'species concept' is particularly stimulating. The only black spot of the book is perhaps the Prologue in which the author has not succeeded in his attempts to be poetic.

'Elementary Biochemistry' is an ideal down-to-earth text-book of the 'sure success' variety. It makes no academic claims but presents the subject matter very clearly and simply. The publishers could have done a better job even though they have priced the book nominally. Care has, however, been taken to represent the chemical formulae correctly.

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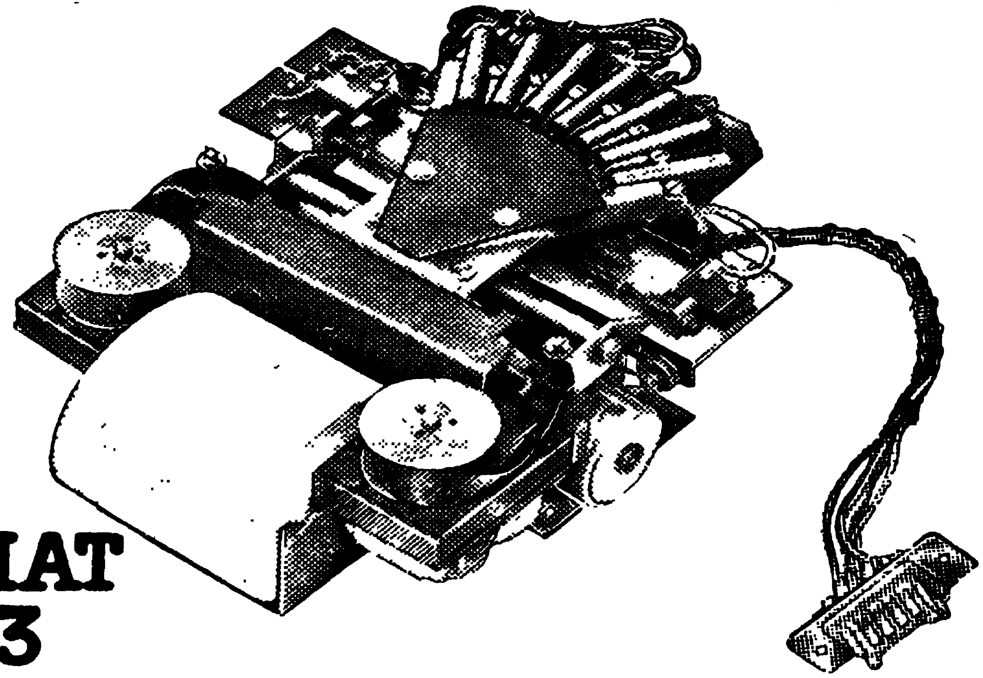

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LETTERS

Smelly shrews

I

Sir, The article on shrews by Aruna Mohan (*S.R.*, May 1977) was very informative, interesting and readable.

I may add the following interesting facts about these tiny mammals.

1. Though shrews are the smallest mammals,, one species of Otter Shrews (Fam. Potamogalidae) is even more than 60 cm in length.
2. Shrews mature in 4-10 months, gestation period is 13-25 days long, and the number of young varies from 2 to 10.

Newborn babies are naked, blind and very small with a body weight of 1/2 gm.

3. In some species of shrews, the young ones are led about by the mother One baby holds onto the mother's rump with his teeth, another holds the first baby's rump, and so on The grip is so firm that if the mother is lifted, the chain of babies comes with her.
4. When a shrew is faced by an intruder of the same species the following is the likely sequence of events: (i) the intruder springs aside, or (ii) the resident raises his head and squeaks and the intruder runs away, or (iii) the resident squeaks and runs away.

I would like to point out that though shrews are very sensitive and delicate, and often die of fright when caught, the average life span is 12-18 months and not less than a year as mentioned by Dr. Aruna.

S. Aftabuddin
Deptt. of Zoology
Patna University
Patna

II

Sir, I would like you to publish similar accounts of other insectivores such as hedgehogs and moles. Such articles will be of great interest to your readers.

R. Chandra Shekhar
B-77, Airport Colony
Madras-600027

Asbestos, smoke and larynx cancer

Sir, The Medical Note on **Asbestos and smoke cause larynx cancer** (*S.R.*, Jan 1977, p. 54) is very interesting and our readers should disseminate the information to those who are exposed to asbestos contamination. The widespread use of asbestos (including asbestos-cement) as pipes, sheets, insulation materials, etc., is also becoming a non-occupational route of exposure. Proper safeguards should be taken to prevent the ill-effects of exposure to asbestos dust in particular, especially in the insulation trade.

In this connection I would like to refer, for the benefit of the readers, to an exhaustive and valuable review article: Asbestosis: A reassessment of the overall problem by Thomas J. Haley of the National Centre for Toxicological Research, Food and Drug Administration, Deptt of Health, Education and Welfare, U.S.A., in the *Journal of Pharmaceutical Sciences* (1975, Vol. 54, No. 9, pp. 1435-1449). It gives, besides the sources and chemistry of asbestos, its industrial hygienic and biochemical aspects, animal and human toxicology and carcinogenesis. There are 246 references to the literature available on the subject.

The size of fibres appears to have significant relationship with cancer production.

S. Sankarasubramanian
Professor of Chemistry
Jawaharlal Institute of Post-Graduate
Medical Education and Research
Pondicherry-605006

Metal complexes

Sir, I have read with profound interest the article **Metal complexes in analytical chemistry and industry** by Dr. V. V. Ramasastry (*S.R.*, Feb. 1977). The article provides comprehensive knowledge about metal complexes. Nowadays coordination chemistry is one of the most intensively studied fields of inorganic chemistry and it forms the main pillar of chemistry.

Although Dr. Sastry has given analytical and industrial application of metal complexes which are of great importance, I request you to introduce the medicinal and bioinorganic aspect of metal complexes which is the latest field of research.

D. D. Ozha
Chemical Laboratory
D.P.A.P. 24 Paota, Jodhpur

Mathematical puzzle

Sir, The method described to find out the answer to the mathematical puzzle (*S.R.*, Dec. 1976) is not correct, especially the second sentence. The easy and correct method is as follows:

The sum of 5 digits being 35 the mean value is 7. As only 3 consecutive digits are used, the difference between the smallest and the largest digit is 2. The 3 digits must be 6, 7 and 8 to satisfy the above conditions. (If 5, 6 and 7 are used, the sum of

5 digits will be less than 35 and if 7, 8 and 9 are used, the sum will be more than 35).

To make the sum of 5 digits, an odd number (35), the digit in the 3rd place must be odd, as others come twice making the sum of digits in 1st, 2nd, 4th and 5th places an even number. So 7 is in the 3rd place. Since 86 is not divisible by four, 68 must come at the end. The number is 86768.

K. SUGATHAN
Associate Professor and Head of Cardiology Division, Medical College
Kozhikode-673008

Sound waves, a question

Sir, I shall be grateful if any scientist in India or abroad answers my question:

Is there any technique by which a bundle of pronouncible sonic waves of different frequencies (transmitted energy) can get spontaneously converted into microwaves (radiated energy) without the aid of any instrument? If so, kindly let me know the technique.

M. MITRA
Medical Officer
IISCO Ore Mines Hospital
P.O. Gua (S.E. Rly.) 833213

Is it Home Reporter?

Sir, I am distressed at the way *Science Reporter* is changing.

Now that you have a regular "For Her" feature, perhaps we can look forward to the inclusion of such features as "Kiddies Corner" or "Knitting and Darning for Post-graduates."

There are more than enough of these "family magazines" in India but there are not enough scientific magazines.

So could you dispense with the fun and games and salvage *Science Reporter* before it becomes another Home Reporter?

ARUN KUMAR
D-II/16, Shahjahan Road
New Delhi-110011

P. G. diploma in rural science

Sir, In view of the top priority being given to 'science and rural development' by organisations such as U.G.C., C.S.I.R., I.C.A.R., I.C.M.R., I suggest that universities should start a post-graduate diploma in 'Rural Science' for science graduates. The duration may be for two years. The syllabus must include: 1. Primary health care; 2. Sanitary conditions; 3. Dispelling superstitions; 4. Pump-set; tractor maintenance and repair; 5. Fertilizer and pesticides application; 6. Soil and water analysis; 7. Gobar gas technology; 8. Family welfare; 9. Rural transport; and 10. Modern methods of farming.

The emphasis should be more on practical training: 25% theory, 50% practicals, 25% field study. After the diploma the candidates could be absorbed in villages.

Such a diploma will go a long way in inculcating social responsibility in science students and developing respect towards science among villagers.

A. JAGADEESH
Convenor
Society of Science for People, 2-275, Nawabpet
Nellore-524002 (A.P.)

Earth's shape

Sir, Flattening has been described by K. K. Rampal in the article **Satellites and the figure of earth** (*S.R.*, June 1977) as a measure of the oblateness of the ellipsoid. As the earth is more pear-shaped than an oblate spheroid, some other parameter instead of flattening should be evolved.

It is true that the geoid has a very irregular surface and does not correspond to any geometrical figure. Yet, according to Prof G. Gamow, the 1956 Kalinga Prize winner, the earth, in spite of its seemingly irregularities, is more spheroidal than an ordinary playing ball bloated to earth's dimension.

S. K. GURTU
Defence Science Laboratory
Metcalfe House
Delhi-110054

Wild life

Sir. G. M. Natarajan in **They are wild but need our protection** (*S.R.*, March 1977) has given data on the position of wild life in our country But, unfortunately, there are some mistakes which need correction.

The author has mentioned that the great Indian rhinoceros is found only in Assam. But the animal is found in Assam as well as in Jaldapara and Garumara sanctuaries of West Bengal. The author has also mentioned that the golden langur is found in India only. It is found in Bhutan also. Kaziranga, as menioned by him, is a sanctuary, and also a National Park. The definition of National Park as mentioned in the Glossary of Terms used in *Nature Conservation and Wild Life Management* (as per Indian Board of Wild Life, 1952) is "An area dedicated by State for all times to conserve the scenery and natural and historical objects of national significance, to conserve wild life therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications as local conditions may demand", and not as mentioned by the author

—a place for public recreation and tourism.

A. K. LAHIRI
Principal,
Forest Rangers College
Kurseong 704220
Dt. Darjeeling (W.B)

Dental caries

Sir, I read the article **Dental caries —causation and prevention** (*S.R.*, May 1977) by S.S. Sidhu with keen interest. Shri Sidhu has stated that there should be no ill-fitting dentures in the treatment of dental caries. I need a clarification on this point. It seems there is no use of denture in the treatment of such disease.

MD. ISLAM
17, Tanti Bagan Road
Calcutta-700014

Of course, the artificial dentures are not a treatment for dental caries. If a person is using artificial dentures, i.e., partially removable or fixed partial dentures which are not well fitting, they can lead to collection of food particles, debris, etc. Fermentation of the food starts formation of caries. That is how an ill-fitting denture can be a predisposing factor in formation of dental caries. It is advisable not to have ill-fitting restorations or artificial dentures.

S.S. SIDHU
Associate Professor & Head
Deptt. of Dental Surgery
All India Inst. of Medical Sciences
Ansari Nagar, New Delhi-110016

Vitamins

Sir, Having read with interest R. Raghunathan's article **ABC of vitamins** (*S.R.*, April 1977), I am tempted to make some important observations regarding vitamins of the B-complex group.

Osteomalacia or rickets, a metabolic disorder of the bone, due to a severe deficiency of vitamin D and calcium, could hardly be associated with a deficiency of the B-complex group of vitamins. However, in a recent study conducted by me, it was interesting to note that the blood levels of all the five vitamins, i.e., thiamine, riboflavin, nicotinic acid, pantothenic acid and vitamin B_6, were significantly depressed in all the osteomalacic patients. This clearly proves the dietary insufficiency prevailing in these patients. It is also well-known that deficiency of a single vitamin of the B-complex group is rare in humans. Such a multiple deficiency arises because these vitamins operate together as coenzymes in various metabolic activities. Probably B-vitamins play a subtle role in facilitating the action of vitamin D or its analogues and calcium in better bone ossification in this syndrome of vitamin D deficiency.

Surprisingly none of the patients had any evidence of peripheral neuropathy, a condition frequently associated with a deficiency of one or more vitamins of the B-complex group. This further emphasises the concept that deficiency of a vitamin need not always accompany the symptom classically associated with that vitamin.

BOMI M. GAGRAT
Quality Control Deptt.
Indo-Pharma Pharmaceutical Works
C-4, MIDC, Thana
Belapur Road
Thana (Maharashtra)

Rh factor

Sir, I am a regular reader of *S.R.* It is very useful for science students. I read with great interest **Applications of blood groups** (*S.R.*, Feb. 1977) by D.P. Bhatnagar. I would like you to publish an article on Rh factor—its causes and remedies.

DEEPAK K. BANERJEE
Kokar, Ranchi-834001
(Bihar)

Suggestion

Sir, Many thanks to the author of the article **Colour TV** (*S.R.*, December 1976). The articles in *S.R.* are informative. I request you to start a new section 'Reader's Questions and Answers'. I would also like you to publish an article on 'Developments in communications.'

M. RADHAKRISHNAN
Alagappa College
Karaikudi-623003

AND SO COMETH MAN

Man, unique among animals, appeared on earth nearly 2.8 million years ago

B. K. BEHURA

THE vast array of plants and animals that we see on the earth today is the result of organic or biological evolution. The age of our planet is estimated at 5,000 million years and life is believed to have originated 2,300 million years ago. During this vast expanse of time, life in varied forms expressed itself and through a wasteful process termed natural selection, by elimination of myriads of forms, the present plants and animals have evolved. Through the same process man has also evolved, although he is of very recent origin compared to other animals. If the time from the origin of life to date is represented in a one-half day scale, then supposing that life originated at 12 midnight, the first "human" primate appeared less than 19 seconds before mid-day and the first "wise man" less than 4 seconds before noon (Fig. 1).

Early mammals and the first primates

During the Mesozoic Era which started about 230 million years ago and lasted about 130 million years, reptiles and huge dinosaurs ruled the earth. Long before the extinction of dinosaurs, through the processes of natural selection, a group of animals became distinct from reptiles to form the ancestors of the mammals. During this early period of mammalian emergence, about 70 million years ago, a line of insectivorous shrews took to life on the trees. From these animals, it is believed, evolved the primates which comprise the lemurs, tarsiers, monkeys, apes and man (Fig. 2).

Modern insectivores exhibit more dependence on the senses of smell and hearing than on the sense of sight. Life on the trees must have demanded the greater deployment of the senses of sight and hearing than on the smell. Fossils of ancient tree-shrews indicate that they had flat noses which bespeak of lesser use of olfactory sense compared to the dependence on the eye and the ear. This sets them among the most primitive primates rather than among the insectivores. Living representatives of tree-shrews occur in India, viz., the Indian tree-shrew *Anathana ellioti* of the dry and moist deciduous forests of peninsular India, south of the Ganges; and the Malay tree-shrew, *Tupaia glis*, whose range extends from Burma to Assam and the eastern Himalayas.

From the ancient tree-shrews evolved the lemurs. To some extent the latter are intermediate between insectivores and monkeys. At the beginning of the Tertiary Era, about 63 million years ago, lemurs lived all over the world and were represented by large forms. After the Oligocene period, about 25 million years ago, they began to disappear from Europe and America as true monkeys made their appearance. The present day forms of lemurs are confined to Malagasy (Madagascar). In the Indian region, however, a single species, *Cynocephalus variegatus peninsulae*, occurs which is confined to southern Burma.

From the lemurs evolved a group of animals called the tarsiers. During the Eocene, that is between 58 million and 36 milion years ago, they flourished in large numbers as evi-

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Dr. Behura is Professor & Head, Deptt. of Zoology, Utkal Univ., Bhubaneshwar 751005

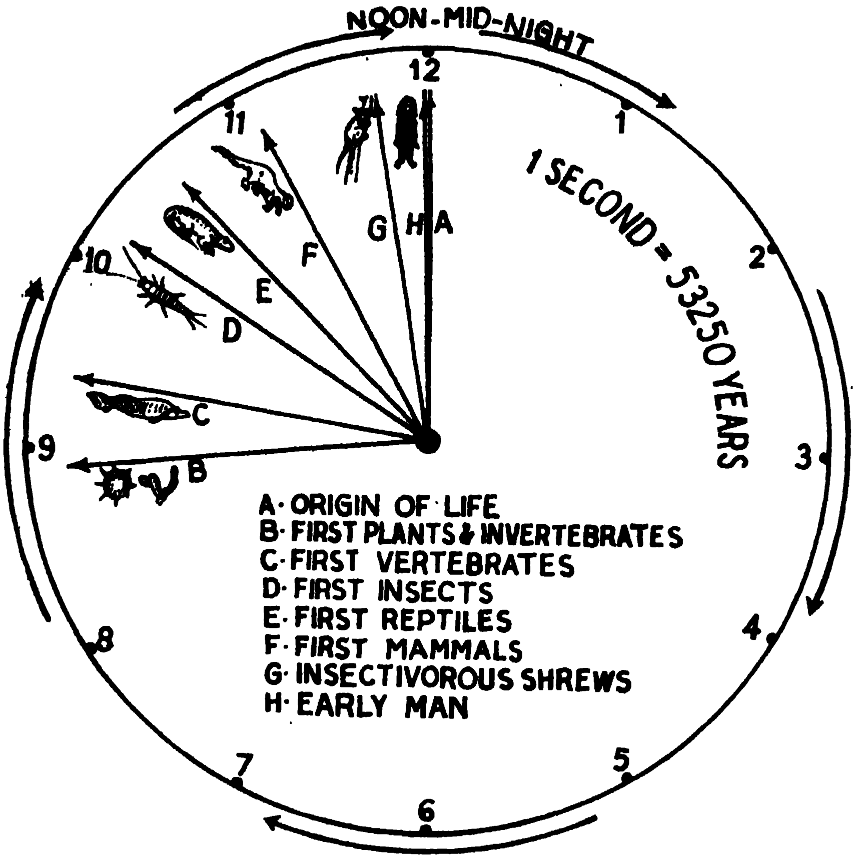


Fig. 1. Time of origin of life to date represented in a half-day scale. Midnight corresponds to origin of life 2300 million years ago. One second represents 53,250 years approximately

denced by hundreds of fossil species. They are now represented by a single species confined to the Philippines, Sumatra and Borneo.

In the ancient tree-shrews, lemurs and tarsiers, a remarkable trend is noticed. They depended more and more on vision and hearing than on smell. The eyes enlarged and shifted their position from the sides to the front. Both the eyes could see an object simultaneously due to stereoscopic vision; brain could make accurate judgments of the distance of an object. This trend proved to be of tremendous consequence as it culminated in the evolution of primates into man (Fig. 3).

At the beginning of Oligocene, that is, 36 million years ago, the descendants of the ancient tree-shrews evolved in two distinct directions. One line evolved to give rise to animals whose modern forms are the marmosets and the New World monkeys with prehensile tails, while the other line gave rise to the ancestors of Old World monkeys with stubby tails, apes and man.

The parting

About 25 million years ago, at the end of Oligocene or early Miocene, the ancestors of apes and man began to evolve on separate lines. The former is known as Pongidae and the latter Hominidae. Both were higher primates. While the former lived on the tree, the latter were terrestrial. The modern forms of Pongidae are the gorilla and chimpanzee of Africa, gibbons and orangutan of Southeast Asia and the East Indies (Fig. 4). In accordance with their life on the trees, they have developed long arms for brachiation, i.e., swinging from tree to tree. The ancestors of both these groups are believed to be closely related to *Proconsul* (Pongidae) which lived in Africa during early Miocene, and is probably the earliest ancestor of the modern apes (Fig. 3).

The early Hominid group were somewhat erect animals and lived on the ground. Because of their terrestrial habits, their legs became longer and stronger, and the big toe lost its grasping ability. Acute sense of hearing and three-dimensional vision were great assets for ground life and so they developed.

The arms were no longer used as powerful grasping organs but were free to be employed to serve other purposes. The trunk balanced perfectly with the basin-shaped hind or pelvic girdles. The cerebellum increased in size probably in response to constant stress and strain necessitated by life on the ground. The spinal cord gradually shifted under central cavity of the cranium—the foramen magnum. This helped the animal to have a straight spine, an upright gait and helped him to look forward. Thus evolved, about 14 million years ago, the forward-

"I was always skeptical of the theory that man is the descendent of an ape until I met, er, your husband."

looking ground-walking primate, who can be termed as Pre-man.

The first primate to embark on the road to humanity was probably *Ramapithecus*, which lived fourteen million years ago and is known from the fragments of its teeth and jaws unearthed in the Siwalik ranges of India. It resembled more closely early man than an ape.

Ramapithecus was followed about five million years ago by *Australopithecus*. Early forms of this "African ape-man" lived in Southern Africa. They were about 1.2 metres tall, had teeth like modern man and probably walked erect. More recent forms of this ape-man evolved into "handy-man" (*Homo habilis* =*Australopithecus africanus*) about three and a half million years ago. They used crude stone tools, and ate a varied diet including game they hunted (Fig. 5).

About a million years ago appeared the first "human", *Homo erectus*, whose brain was large enough to be called human. He was about 1.5 metres tall and walked erect. He was probably a slow traveller and lived by hunting and gathering. He knew the use of fire. Small populations of *H. erectus* are known to have lived in Africa, Eastern Asia and Europe. They were probably the same species as the Java man (*Pithecanthropus erectus*) and the Peking man (*Sinanthropus pekinensis*) and lived between 1 million and 30,000 years ago.

The next to come on the stage of human evolution was the Neanderthal man, *Homo neanderthalensis* (=*Homo sapiens neanderthalensis*). He was short, heavily built, strong, and had protruding jaws, little chin, sloping forehead, heavy brow-ridges above the eyes and was somewhat a "brute". He had a large brain, and was intelligent, manufactured tools and buried the dead with ceremony. This "wise man" evolved about 200,000 years ago and was firmly settled in Europe about 100,000 years ago (Fig. 6).

During the last ice age, about 50,000 years ago, the Neanderthal man was wiped out. Nobody knows for certain what exactly led to his extinction It might have intermingled with the Cro-Magnon man, *Homo sapiens fossilis*, but was defeated in the struggle for existence because the latter were of larger stature, more vigorous and more intelligent. The cranial capacity of Cro-Magnon man was larger than that of the Neanderthal man and the dentition was typical of modern man. They lived in caves and rock shelters; carved tools and ornaments from ivory, manufactured finely chipped stones for use as arrow points and spear points. They were also artists as is known from the carvings on rocks under which they took shelter. They belonged to the stone age and lived in a world dominated by ferocious mammals like the sabre-toothed tigers, wooly mammoths, large bears, bisons and wolves. Constant fear must have

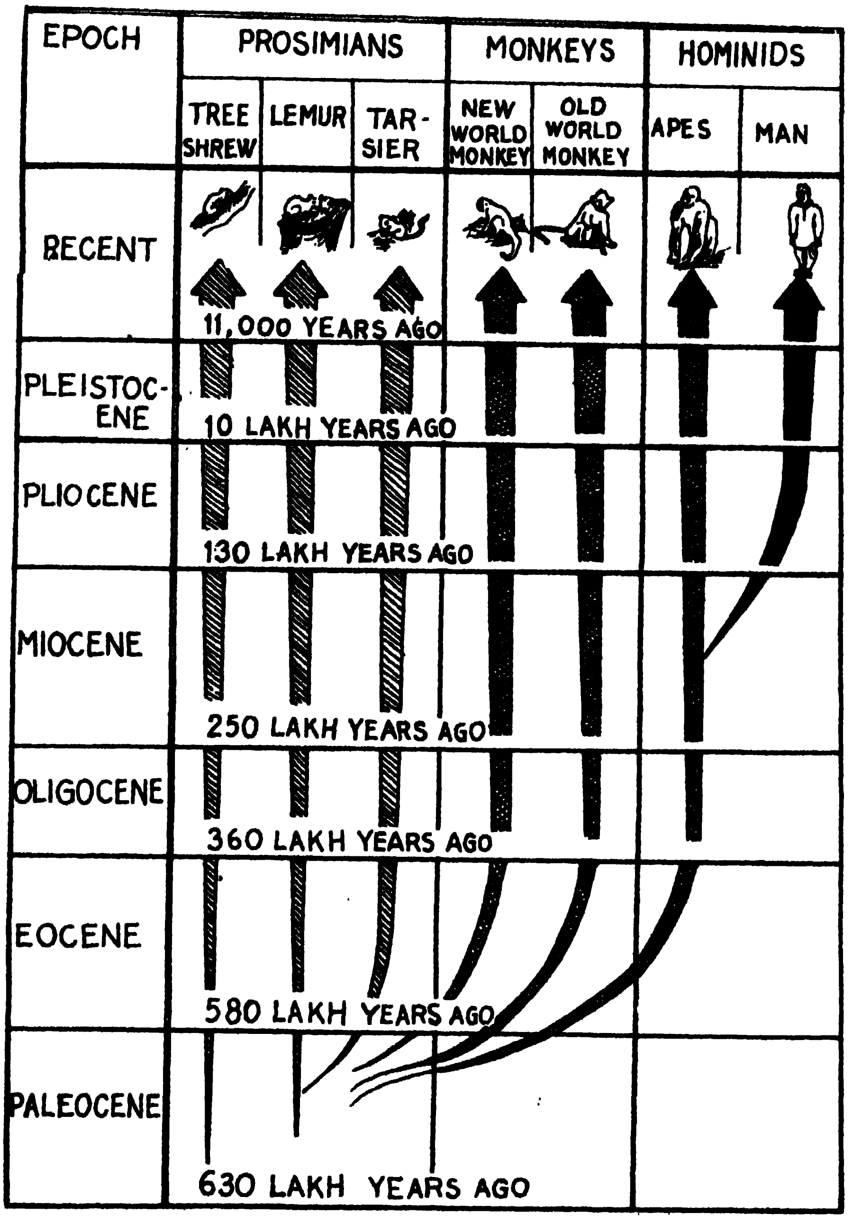
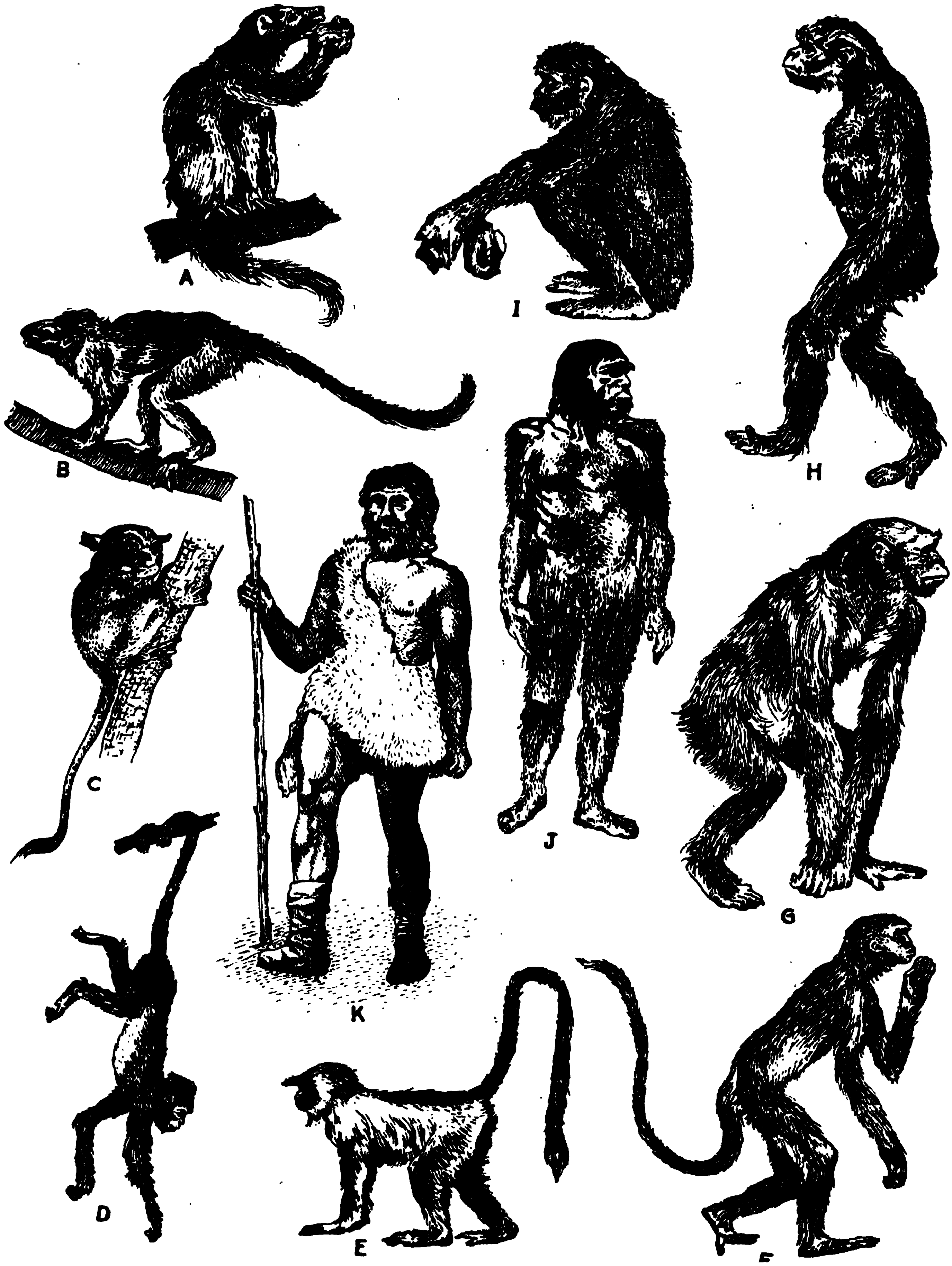


Fig. 2. Time scale of the evolution of primates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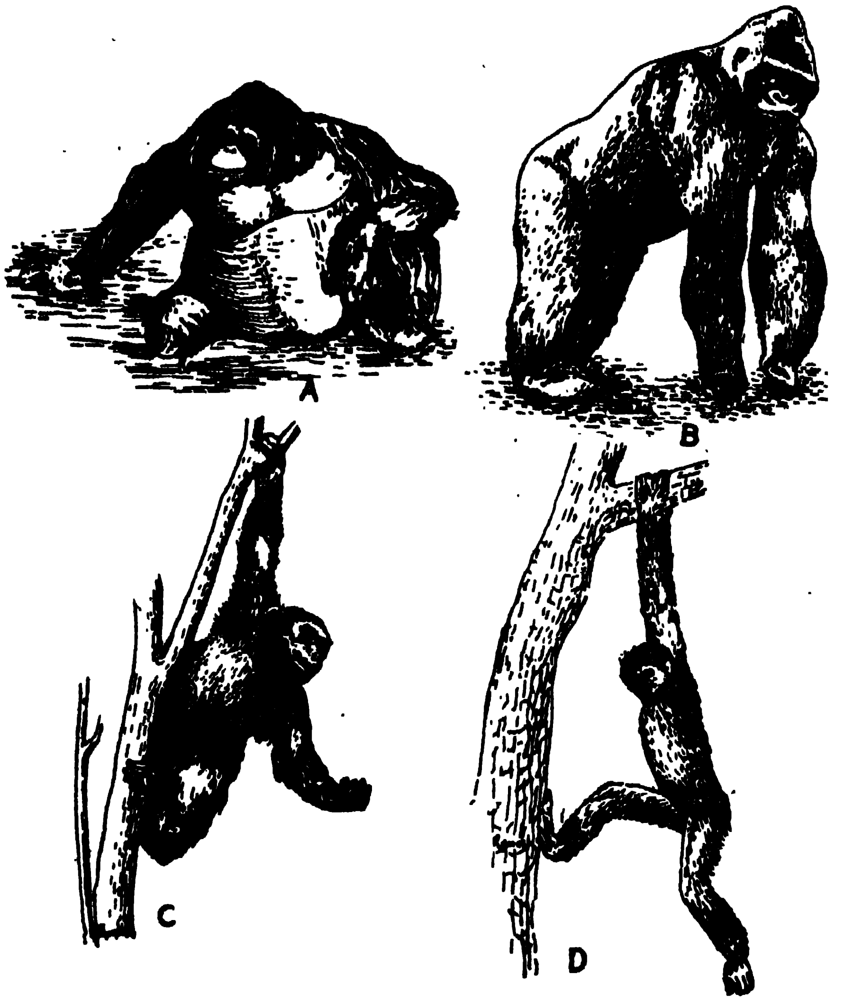


Fig. 4. **The four living great apes: A-Orangutan. B-Gorilla, C-Chimpanzee, D-Gibbon. In all four of these primates, note the length of the arms as compared with legs**

sharpened their intelligence and encouraged greater use of hands for preparation of tools and weapons. The descendants of Cro-Magnon are the modern man (*Homo sapiens sapiens*) which dominate the earth.

About 8,000 to 10,000 years ago, the earth witnessed the disappearance of the large fearsome mammals, the reasons of which are not known. Man devised better tools and better ways of living which led to the evolution of different cultures.

On the path of civilization

Between 10,000 and 6,000 years ago, man began the use of clothes and developed new skills for food gathering. They developed improved methods of hunting and fishing. Domestication of plants and animals occurred during this period and the foundations of improved methods of agriculture were laid. After this, civilization developed ra-

Fig. 3. **Evolution of primates and man: A-Early Primate *Pleasiadapis*; B-Primitive *Smilodectes*; C-Ancestral tarsier *Necrolemur* of Miocene; D-Spider monkey (Family Cebidae); E-*Mesopithecus*, the ancestor of the modern langurs; F-*Pliopithecus* (Family Pongidae, apes and their ancestors); G-*Proconsul*, the ancestral ape of Africa; H-*Ramapithecus* (Family Hominidae, man and his ancestors) from India is known only from fragments of its teeth and jaws; I-African ape man *Homo habilis* (*Australopithecus*) lived in South Africa; J-First true man, *Homo erectus*, K-Cro-Magnon man, *Homo sapiens fossilis* was the first modern man and appeared in Europe about the of the last Ice Age, some 40,000-50,000 years ago**

Man's oldest ancestor

THE earliest known member of man's family tree was the *Ramapithecus*, which became extinct about 8 million years ago. The first *Ramapithecus* fossil was discovered in 1932 in the foothills of the Siwalik Hills near Chandigarh. G. Edward Lewis, a young Yale University graduate found an upper jaw of what he called "manlike apes." He named it *Ramapithecus brevirostris*. (The generic name simply means "Rama's ape", whereas the species name is the Latin for "Short-snouted.")

Since Lewis' discovery, some two dozen fossils of *Ramapithecus* genus have been excavated from places in Europe, Asia and East Africa. Study of these fossils, mainly jaws and teeth, indicates that the *Ramapithecus* had adapted to a way of life quite different from that of most of its forest dwelling relatives (*Scientific American*, May 1977). The jaws and teeth of *Ramapithecus* had close resemblance with those of the African hominid *Australopithecus*, which came four million years later. There is no fossil record for the intervening period. But it is believed that *Ramapithecus* may well have given rise to the later hominid *Australopithecus*.

The famous palaeontologist L.S.B. Leakey has suggested an alternative hypothesis. According to him, both *Homo* (man) and *Australopithecus* branched independently and directly from *Ramapithecus*.

• B.B.

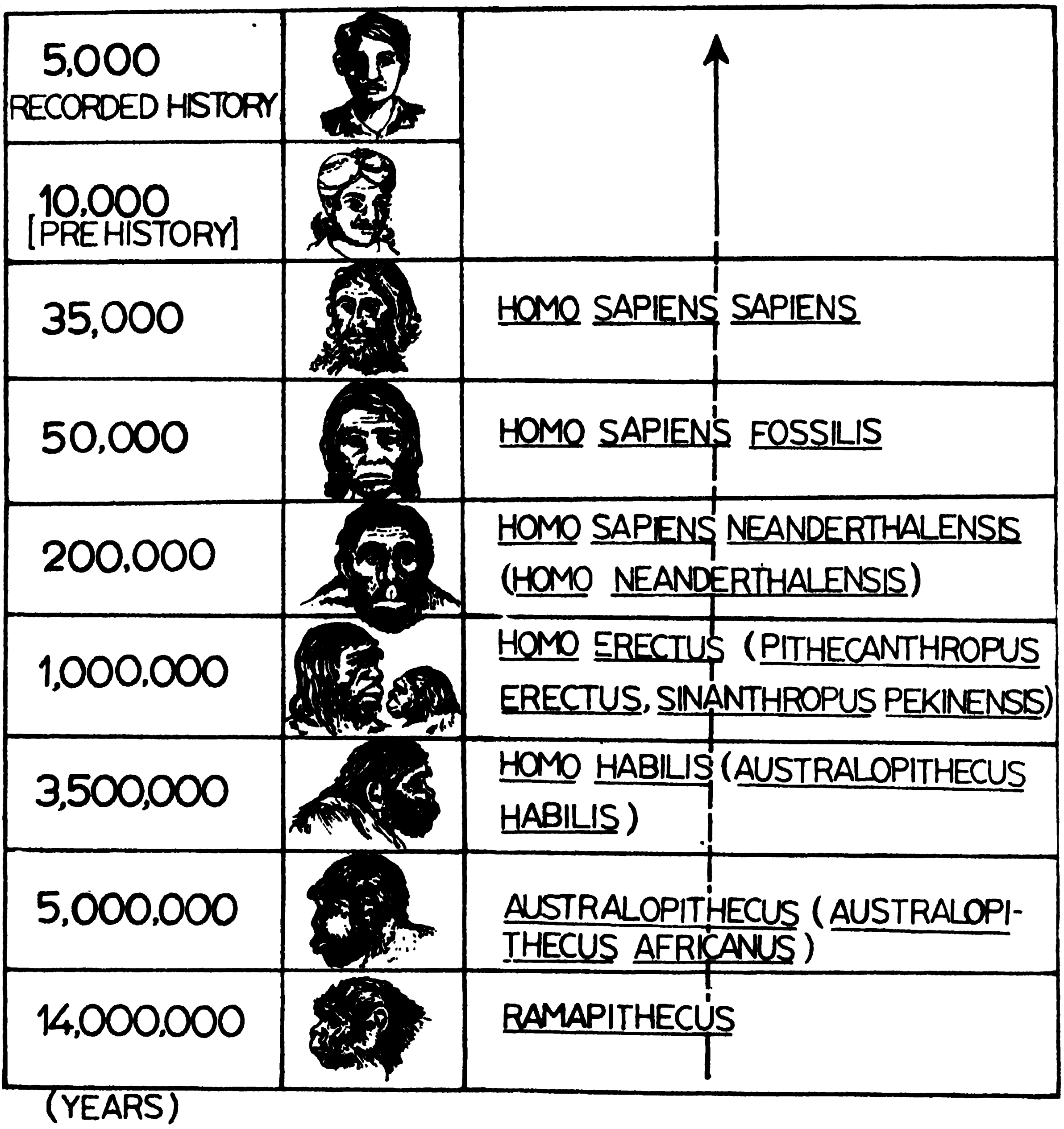


Fig. 5. Probable line of descent of man

pidly. Human settlements sprang up. Leaders became rulers. Conflicts of interests led to wars. By the time the ancient civilization of Sumeria flourished some 6,000 years ago, many of the features of the modern society had been established.

So human evolution took place from non-human forms some 2.8 million years ago, as evidenced from fossil findings in Africa which is regarded as the cradle of human evolution. The recent discovery of a 2.8 million year-old human skull in Kenya by Richard Leakey, son of the renowned husband-wife British anthropologist team, Louis and Mary Leakey, and the discovery of human remains of 70,000 to 80,000 years ago in Border Cave in southern Africa between Swaziland and Natal by Adrina Boshier and Peter Beaumont have created worldwide interest. The findings in the Border Cave show that the people inhabiting them were definitely *Homo sapiens sapiens*. They manufactured a variety of tools, knew the art of mining, they could count, believed in after-life and buried the dead with ceremony. These recent discoveries tend to show that by 80,000 B.C. the modern man *Homo sapiens sapiens* was already on the path of civilization indicating

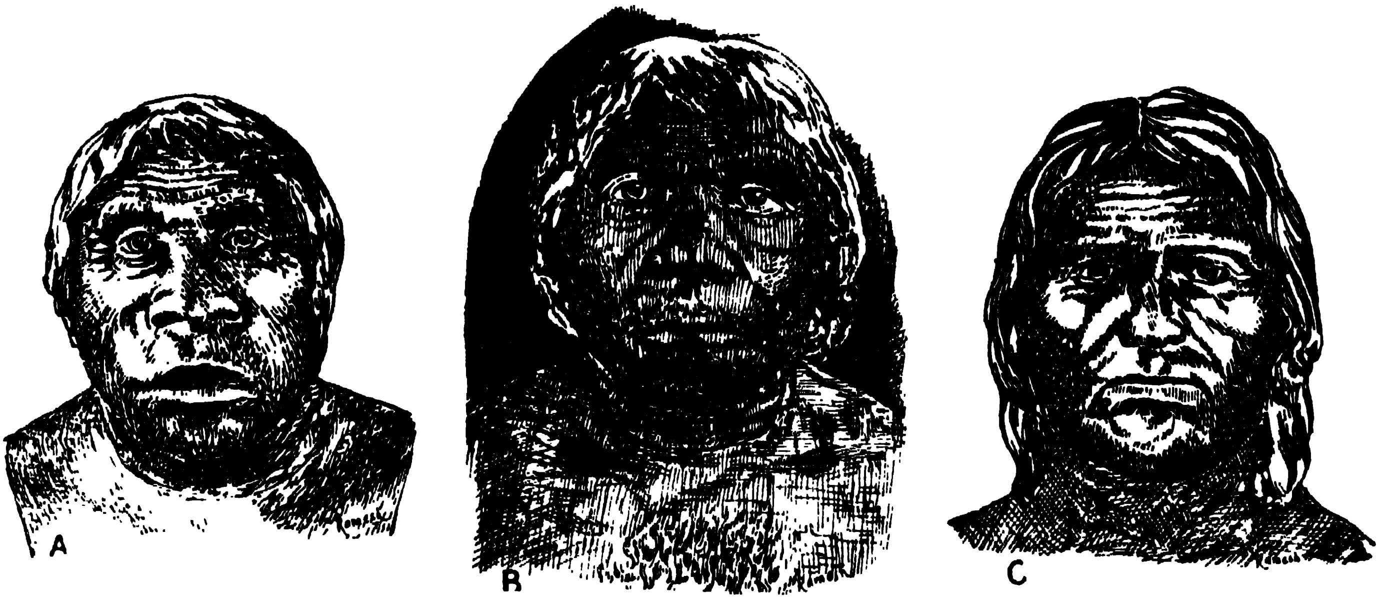


Fig. 6. Probable appearance of different kinds of early man: A-First human, *Homo erectus*. B-Neanderthal man; C-Cro-Magnon man

thereby its appearance about 100,000 years ago rather than 37,000 years ago as believed earlier.

Uniqueness of man

Man is unique among animals, being the most outstanding product of evolution. Mankind is the product of two types of evolution. One is biological evolution which works through mutation of genes. The other is psychological or cultural evolution. The latter evolution has been operative most during last 100,000 years with the emergence of the "wise man" *Homo sapiens*. The unique characteristic of man is his ability to direct and control his own evolution and for this his most powerful tool is science. Each generation has transmitted to the next generation all that he has learnt, invented and created.

However, all living human beings inhabiting the earth belong to one and a highly variable species *Homo sapiens* (Fig. 7). Due to genetic isolation, mutation, selection and migration, they are divided into a large number of races but all can potentially produce fertile offspring when inter-crossed.

The future

Increase of lifespan. As a result of improved living conditions, better nutrition and better medical care, the average lifespan of man is progressively increasing. In addition, modern science has been trying to overcome hereditary, physical and mental defects. Thus the role of selection in human evolution is also diminishing.

Merging of separate populations. We now live in one world. We think of one society, the human

Future man

FROM the squat, but upright, *Australopithecus* of around 4 million years ago, to *Homo erectus* of 500,000 years ago, man has evolved through variants of *Homo sapiens*, like Neanderthal Man of 70,000 years ago, to his modern form, *Homo sapiens sapiens*. What will the future man be like? According to American anthropologist H.L. Shapiro the future man, or *Homo futuris*, as he calls it, will be taller, have a dome-shaped almost hairless head, an improved slightly larger brain, and possibly be without his little toe.

Other scientists envisage an offshoot of future man called *Homo aquaticus*, or water man who could adapt to a marine environment, as earth's resources on land become depleted.

Still others like the Russian scientist A.P. Bystrov, and experts of the Natural History Museum, London, believe that man's evolution stopped long ago. They say there is little sign that *Homo sapiens* has shown much biological change since the last ice age.

B.B.

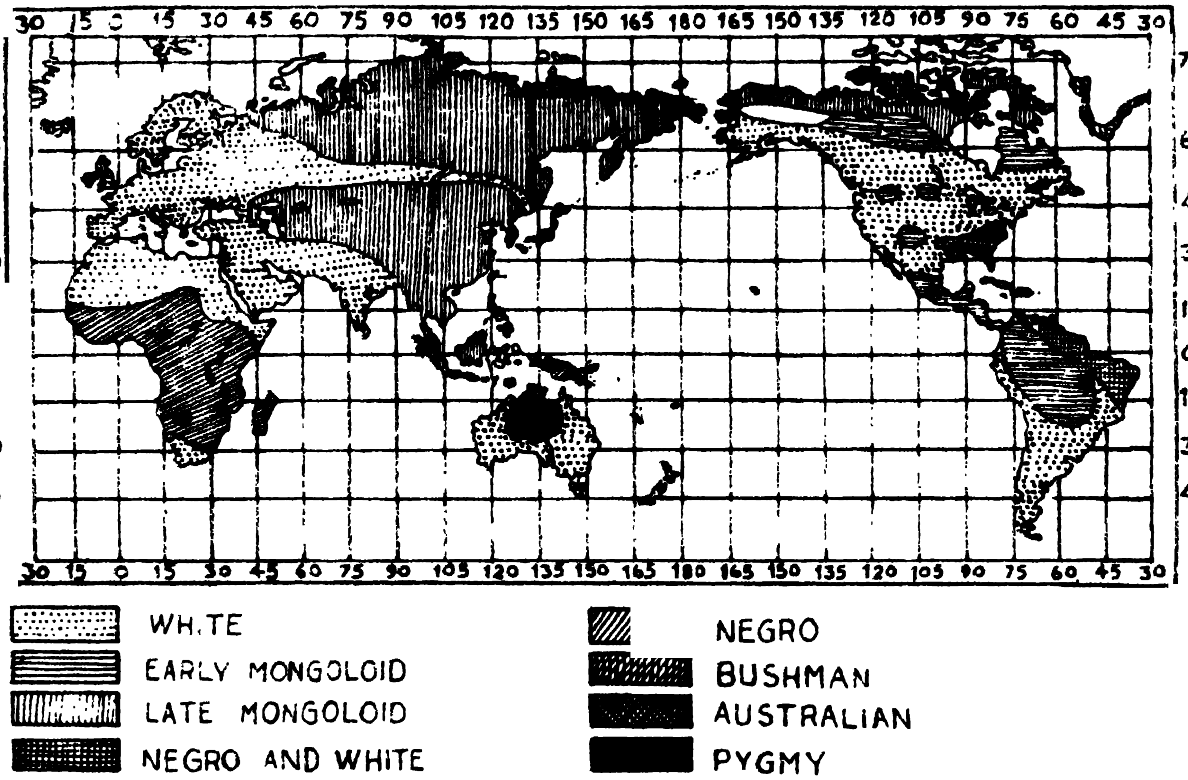
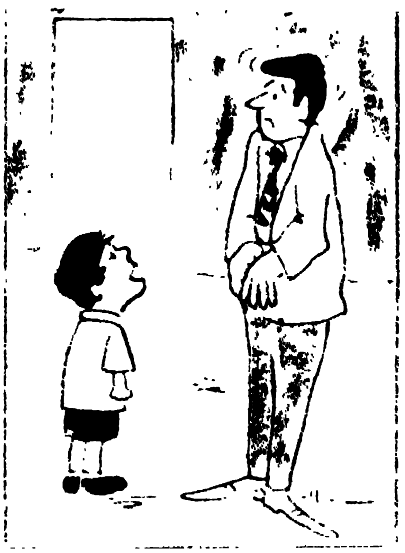


Fig. 7. The present distribution of different "races" of man is mainly the result of many great migrations

society. Intelligence is not considered as a racial trait but as an individual matter. Since racial differences are not fundamental from a genetic stand point and geographical barriers for mankind have vanished due to overwhelming improvement in communications, there is now trend towards marriage between different populations which perhaps will progressively merge into one



"*Does it mean, Dad, that I too am a descendent of an ape?*"

Increase in population. The population has been progressively increasing (Table 1). Since the last decade, it has been going up by leaps and bounds. No one can predict with certainty the long-range consequences of population explosion about which governments, scientists and the common man has become more conscious and concerned.

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Table 1. Human population through the ages

1,000,000 years ago	125,000	
12,000 B C.	10,000,000	(10 million)
1650 A.D.	545,000,000	(545 million)
1750 A D	791,000,000	(791 million)
1850 A.D.	1,171,000,000	(1,171 million)
1900 A.D.	1,650,000,000	(1,650 million)
1950 A.D.	2,400,000,000	(2,400 million)
1971 A.D.	3,706,000,000	(3,706 million)
2000 A.D. (expected)	6,000,000,000	(6,000 million)
2006 A.D. (expected)	7,412,000,000	(7,412 million)

M. C. BANSAL

The transistor switches have become the basic building blocks for the development of digital electronic circuits

USE OF TRANSISTOR AS A SWITCH

A new era in electronics began with the advent of the transistor. The little giant of electronics came into being in December 1947. Its creators were three American scientists, John Bardeen, Walter Brattain and William Shockley. The invention earned the three scientists the Nobel Prize in Physics in 1956.

A transistor can work well in almost all the applications for which a vacuum tube is employed. The miniature transistor circuits are reliable and consume less power than vacuum tube circuits. Because of their many advantages the transistors have superseded the vacuum tubes in today's electronic age.

Electronic switching is one of the most important functions for which transistors are used in a wide variety of applications such as automatic control systems, automatic measurement and computing systems. The functioning of an electronic switch is similar to a mechanical switch but with the advantages that the former can be operated very rapidly and can be controlled by means of a voltage or a current. Normally, a switch is characterised by two states, 'off' and 'on'. In the 'off' state of the switch, the current is minimum and the voltage is maximum, while in the 'on' state, the current is maximum and the voltage minimum.

To illustrate this, let us refer to Fig. 1, which shows a simple circuit consisting of an ordinary (mechanical) switch S, a bulb B, and a cell of e.m.f. E. In the 'off' state of the switch (bulb B remaining off). the current I passing through it is zero while the voltage V across the switch is equal to the e.m.f. E of the cell. In the 'on' state of the switch (bulb B remaining on) the current I is equal to E/R (R being the resistance of the bulb coil), and the voltage V is zero. Similarly, for a transistor (electronic) switch, the 'off' state is characterised by minimum current passing through and the maximum voltage across the switch, and 'on' state by maximum current and minimum voltage.

Transistor-switch

Fig. 2 shows the circuit of a transistor-switch. The switch entails a transistor Q, load resistor R_c, biasing resistor R, coupling capacitor C, and the power supply V_{cc}. To understand the operation of the transistor-switch, let us first see how a transistor works. In normal operation, the collector-base junction of the transistor is reverse-biased while the base-emitter junction is forward biased. In such a case, charge carriers (positive holes in the case of a PNP transistor and electrons in the case of a NPN transistor) drift from the emitter of the transistor to the collector, and a current flows

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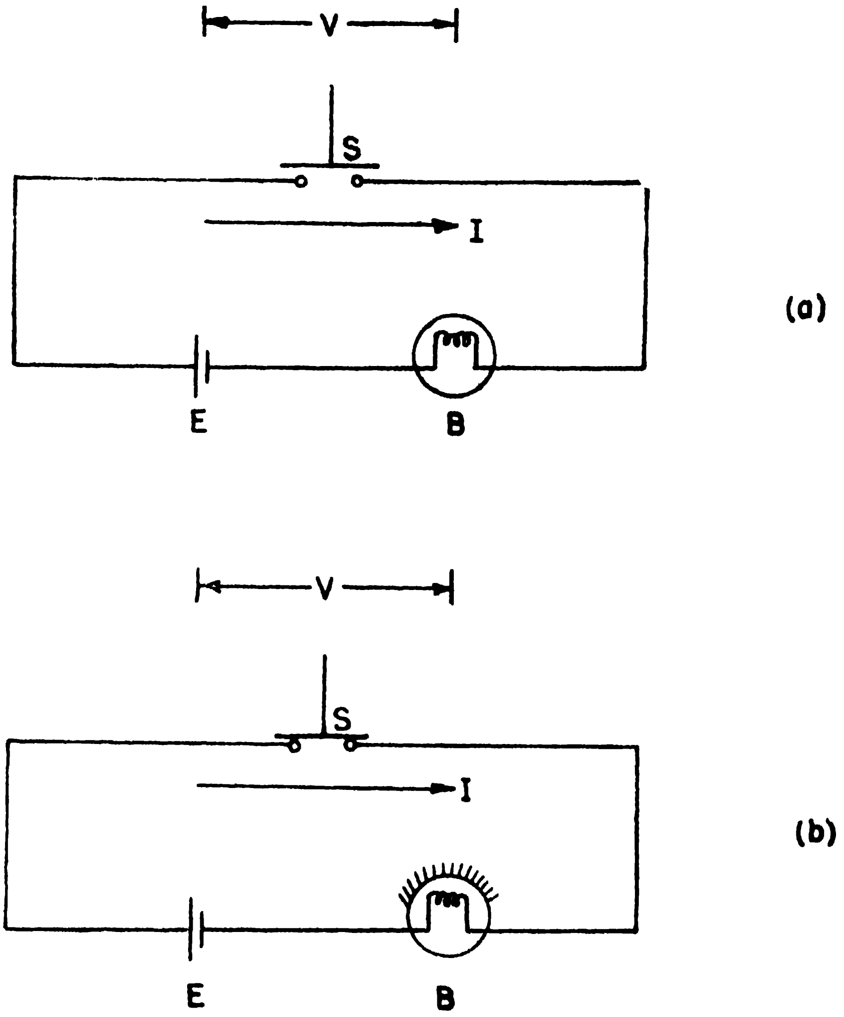

Fig. 1. Ordinary switch arrangements : (a) 'Off' state of the switch (I=0, V=E), (b) 'On' state of the switch (I=E/R, V=0)

in the circuit. If the base-emitter junction is also reverse-biased, there will be no flow of current. Thus, in the transistor-switch circuit (Fig. 2), when the base potential of the NPN transistor *Q* is equal to a particular voltage called the cut-in voltage (being typically +0.1V for a germanium transistor and +0.5 V for a silicon transistor), a current flows through the collector-load resistor R_c and the collector-emitter voltage of the transistor is minimum (almost zero). This is the 'on' state of the switch. In the other case, when the base potential of the transistor is such as to make the base-emitter junction reverse-biased, there will be no flow of current through the collector-load resistor and the collector-emitter voltage of the transistor would be maximum (almost V_{cc}). This is the 'off' state of the switch. Thus, by properly adjusting the base potential of the transistor, the state of the transistor-switch can be changed from 'on' to 'off' or vice-versa.

Let us now consider a different situation in which a pulse is applied at the input terminals of the transistor-switch. In the positive state of the pulse, the base potential of the transistor *Q* will be positive, making the base-emitter junction forward-biased. The switch will be in the 'on' state. In the negative state of the pulse, the base potential of *Q* will not be sufficient to keep the base-emitter junction forward-biased, thereby the switch will be in the 'off' state. The transistor *Q* will remain 'off' for the duration of the pulse at the input, and as soon as the state of the pulse at the input changes from negative to positive again, the transistor-switch will also change from 'off' to 'on'. Thus one would obtain a pulse at the output, which would be complementary to the input pulse.

The output pulse obtained from a transistor-switch can be used in many automatic systems. Apart from its use as a waveform generator, one can find many applications where switching actions are needed. In such cases the output of the circuit will depend on the electrical signals, the two states (of the circuit) being represented by the binary system of numbers. Some of the other important functions of electronics switching circuits are triggering, counting, timing, etc.

Use of transistor-switches in a multivibrator

Another application of the transistor-switch is in electronic multivibrators. The multivibrators belong to a class of oscillators in which the circuit conditions change or relax cyclically between two unstable limiting states.

Fig. 3 depicts the arrangement of a multivibrator circuit. It uses two transistor-switches in such a way that the output of one is coupled with the input of the other. At any instant, when the first switch is 'on', the second switch remains 'off'. As soon as the multivibrator enters this state, the capacitor C_1 starts charging with a time constant $R_{c2} C_1$ while the erstwhile charged capacitor C_2 starts discharging with a time constant R_2C_2. The base potential of the transistor

Q_2 rises from $-V_{cc}$ towards $+V_{cc}$. As soon as the base potential equals the cut-in value, transistor Q_2 changes its state from 'off' to 'on' and transistor Q_1 switches from 'on' to 'off'. Now the capacitor C_2 starts charging with a time constant R_{c1} C_2 while the capacitor C_1 starts discharging with a time constant R_1C_1. The base potential of Q_1 rises from $-V_{cc}$ towards $+V_{cc}$, and after a definite interval of time the two switches again change their states. In this way, this cycle goes on and square waves are obtained at either of the outputs of the multivibrator.

The frequency f of the square waves obtainable from the multivibrator can be given by the following formula :

$$f = \frac{1}{0.69(R_1C_1 + R_2C_2)} \quad \cdots \quad (1)$$

For a symmetrical multivibrator having $R_1 = R_2 = R$ and $C_1 + C_2 = C$, one obtains

$$f = \frac{1}{1.38\,RC} \quad \cdots \quad (2)$$

The frequency of square waves can be changed by changing the values of the resistors R_1, R_2 or the capacitors C_1, C_2.

The typical values of the components and the type of transistors used for generation of square waves of frequency 1 KHz from the multivibrator circuit of Fig. 3 :

Transistor Q_1, Q_2: CIL 701 (Silicon switching transistors),
$R_{c1} = R_{c2} = 2.2$ K Ω,
$R_1 = R_2 = 72.5$ KΩ,
$C_1 = C_2 = 0.01\ \mu$,
$V_{cc} = +\ 6.0$ V.

A multivibrator performs the functions of triggering, timing and waveform generation. One of its useful features is that it can be synchronised to a particular frequency by an external oscillator. This makes it possible to use the multivibrators in frequency measuring equipments. Take the following as an example ;

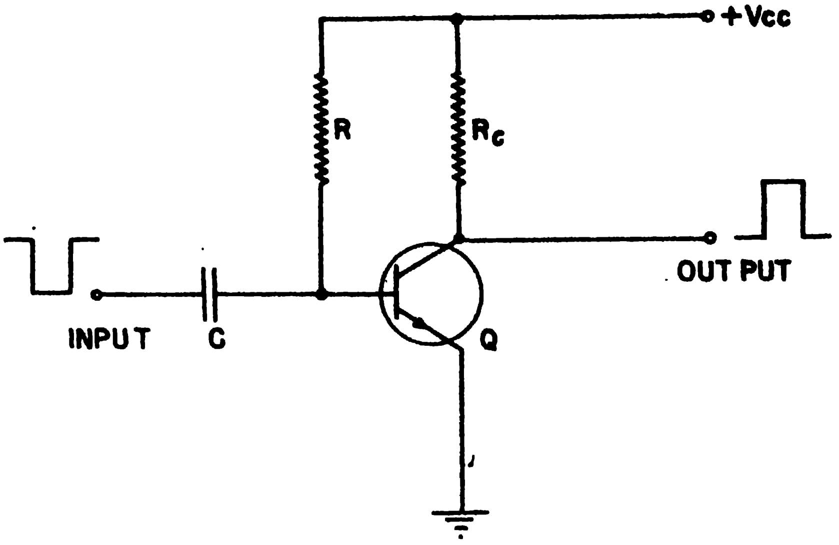

Fig. 2. Circuit arrangement of a transistor switch

When the current flows through the collector-load resistor R_{c1} of Q_1 in the 'on' state of the first switch, there is no flow of current through the collector-load resistor R_{c2} of Q_2 (as the second switch is 'off'). Similarly, when the current flows through R_{c2} (in the 'on' state of the second switch), there is no current through R_{c1}. Thus, if the two load resistors R_{c1} and R_{c2} are replaced by two bulbs (of proper ratings), the latter will become on and off alternately. At any instant, one bulb will be on and the other off. The on and off timings of the bulbs will depend on the values of R_1 C_1 and R_2 C_2. The multivibrator can thus be used conveniently in automatic traffic controls.

In today's fast developing electronic industry, the transistor-switches play a prominent role. And with the availability of micro-miniaturization techniques, these switches are among the most important basic building blocks for the development of other digital electronic circuits.

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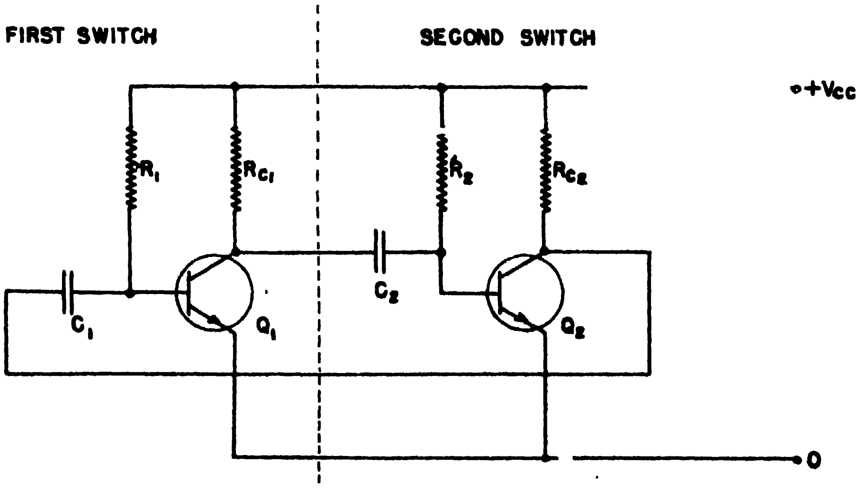

Fig. 3. Multivibrator circuit

DANGERS OF ANESTHESIA AND POLLUTION IN OPERATION THEATRES

Occupational exposure to anesthetic gases can be reduced considerably with improved ventilation systems and scavenging devices in hospitals

P. S. RAMANATHAN

ANESTHESIA means "a loss of sensation to external impression". Broadly speaking, anesthetics are drugs which depress vital functions of all types of cells, but especially those of nervous tissue. Based on the mode of administration, general anesthesia can be subdivided into : (a) inhalational anesthesia (e.g., anesthetic gases/vapours), (b) rectal anesthesia (e.g., non-volatile anesthetics), (c) intravenous anesthesia (e.g., barbiturates), and (d) intraosseous anesthesia (e.g., thiopental sodium, which is administered by injecting the solution into the bone marrow).

Only general inhalational anesthetics are discussed in this article. The only inorganic gas which is widely used to induce surgical anesthesia is nitrous oxide. The other common gaseous/volatile general inhalational anesthetics (GIAs) comprise four groups, namely, hydrocarbons, ethers, halogenated hydrocarbons and halogenated ethers. Their structures are shown in Fig. 1.

Methods of administration of GIAs

The open method is used for liquids. A mask consisting of several layers of gauze is placed over the patient's face and the anesthetic dropped on the mask. The method is wasteful because much of the GIA is lost into the atmosphere and its concentration cannot be controlled. The semi-open method, in which a towel is placed over the mask, gives a better use of the GIA. In the closed method, the

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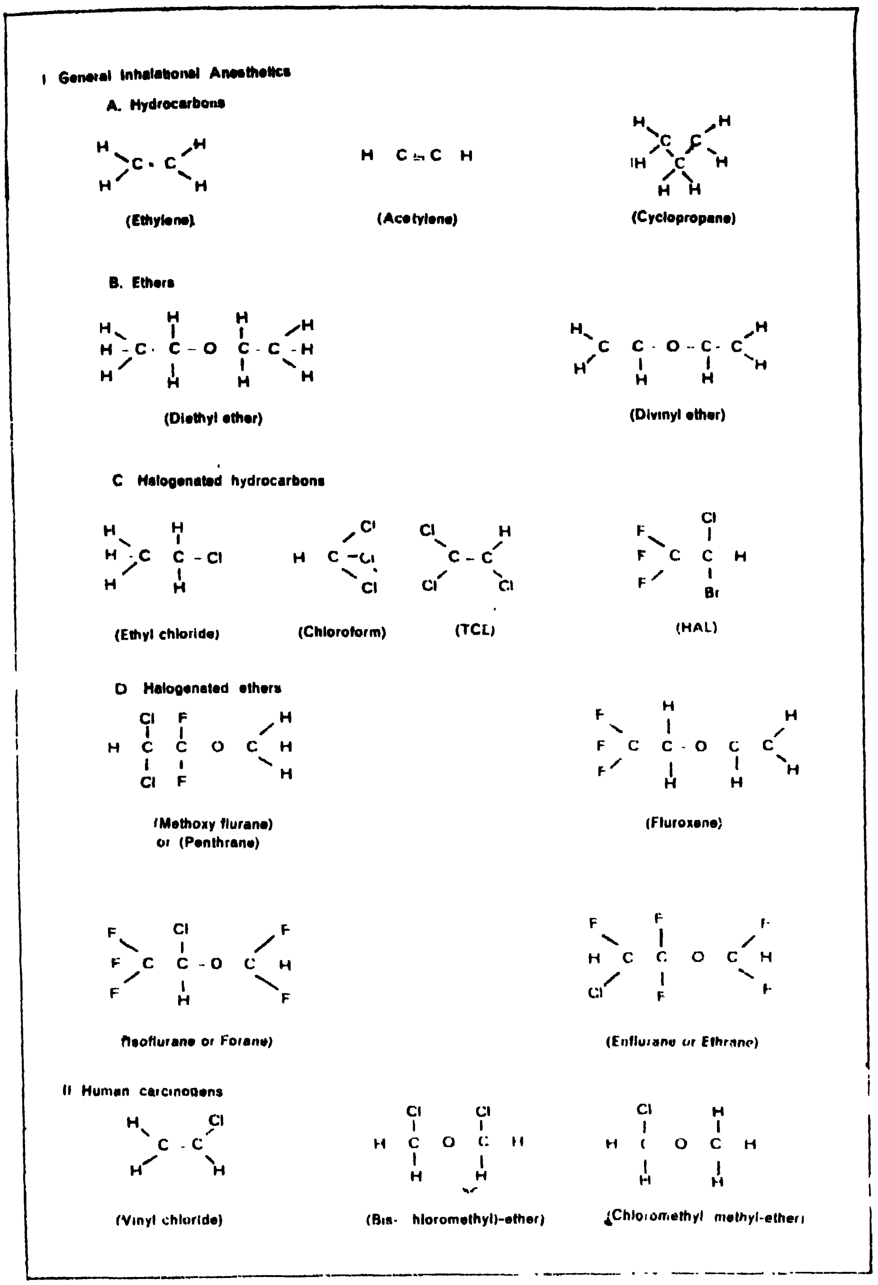


Fig. 1. Structural formulae of some GIAs and human carcinogens

patient rebreathes the anesthetic mixture. The assembly of equipment consists of a mask fitting tightly over the face of the patient and a rebreathing bag which contains absorbents for carbon dioxide and moisture and has openings to introduce oxygen and the anesthetic. In this method, an economic control of the GIA is possible. It permits smooth induction and careful control of the anesthetic stages. The chief disadvantage is that the anesthetic mixture gets diluted by nitrogen which is slowly liberated from the patient's blood into the rebreathing bag. To prevent undue dilution, the bag has to be vented occasionally.

Dangers of anesthesia

The use of GIA in surgery has greatly increased the scope of surgical techniques and has been a great boon for the suffering humanity. It is, however, fraught with a certain amount of danger. In spite of the care exercised during administration, an occasional fatal accident does occur because of various reasons.

Many GIAs are inflammable and explosive. An explosion can take place in the patient's lungs if ether, ethylene, cyclopropane, etc., are used. Any depletion of oxygen supply may cause asphyxia in the patient which may be fatal. Certain GIAs like chloroform can cause cardiac arrest when administered in full anesthetic dose. Trichloroethylene (TCE) gives toxic oxidation products when administered in a closed circuit containing soda lime (which is used to absorb CO_2). It is also known to breakdown into toxic products under influence of heat. There have also been reports concerning (a) liver complications following surgery, (b) impairment of the kidneys, and (c) development of low blood pressure, slowness of heart-beat, inflammation of the skin, headache etc.

Pollution in operation theatres

Depending on the mode of administration of GIA, the operating

"By mistake, I gave him laughing gas instead of anesthesia."

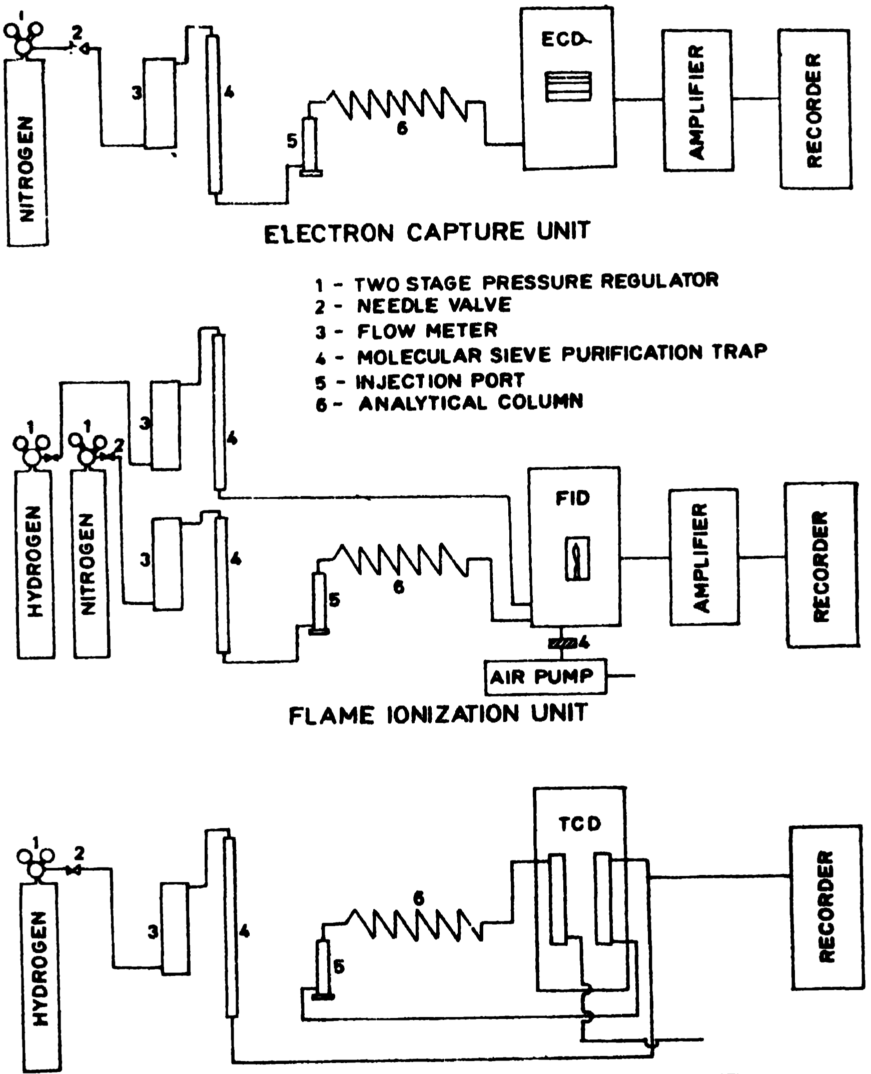
room personnel are likely to get exposed to varying concentrations of the vapours. But the fact that the anesthetist's working condition and environment may affect his health and professional performance has been recognized only recently.

A. I. Vaisman was the first to report in 1967 that an unusually high incidence of headache, fatigue, nausea and pruritus (itching) was detected among 354 Russian anesthetists examined. Evidences of higher rates of spontaneous abortion, premature delivery and congenital malformation have been recorded in case of women anesthetists. In 1968, D. L. Bruce and others published a report which showed an exceptionally higher rate of suicide and high incidence of malignancies among members of the American Society of Anesthesiologists. In 1972, T. H. Corbett and coworkers observed several unusual types of malignancies (such as cancer of the liver, malignancy of the thymus gland, etc.), while surveying 621 female nurse anesthetists in Michigan, U.S.A. Significantly higher incidence of anomalies was also observed in children born to mothers who administered anesthesia during pregnancy. Reports concerning such abnormalities were published around the same period in Denmark and Britain as well. A detailed nationwide survey conducted by the American Society of Anesthesiologists confirmed earlier conclusions concerning higher rates of spontaneous abortion, congenital abnormalities among live-born offsprings, frequency of cancer and fetal abnormalities. Congenital abnormalities in children of unexposed wives of male anesthetists were also reported.

None of the above studies could establish a cause-and-effect relationship. But a critical analysis of the available data reveals clearly that chronic exposure to low concentrations of GIA is related to the statistically higher incidence of these abnormalities among operating room personnel. Prolonged exposure to low concentrations of anesthetic vapours is now believed to be more dangerous than short term exposure to high concentrations. Controlled tests carried out on individuals exposed to traces of GIA have clearly demonstrated that they cause a retardation in the performance of several psychological tasks. The available data seem to suggest that such pollution due to anesthetic vapours affect women more than men.

Similarity in structures of carcinogens and GIAs

Some of the GIAs show very close structural similarity to well-known human carcinogens, substances which encourage the growth of cancer (Fig. 1). As α- and β- chloro ether structures are known to cause carcinogenicity, one may expect similar effects with molecules like isoflurane, penthrane and ethrane. Similarly, the structural similarity of trichloroethylene and vinyl chloride is disquieting.



ELECTRON CAPTURE UNIT

FLAME IONIZATION UNIT

THERMAL CONDUCTIVITY DETECTOR UNIT

Fig. 2. Schematic flow diagram of gas chromatographic units

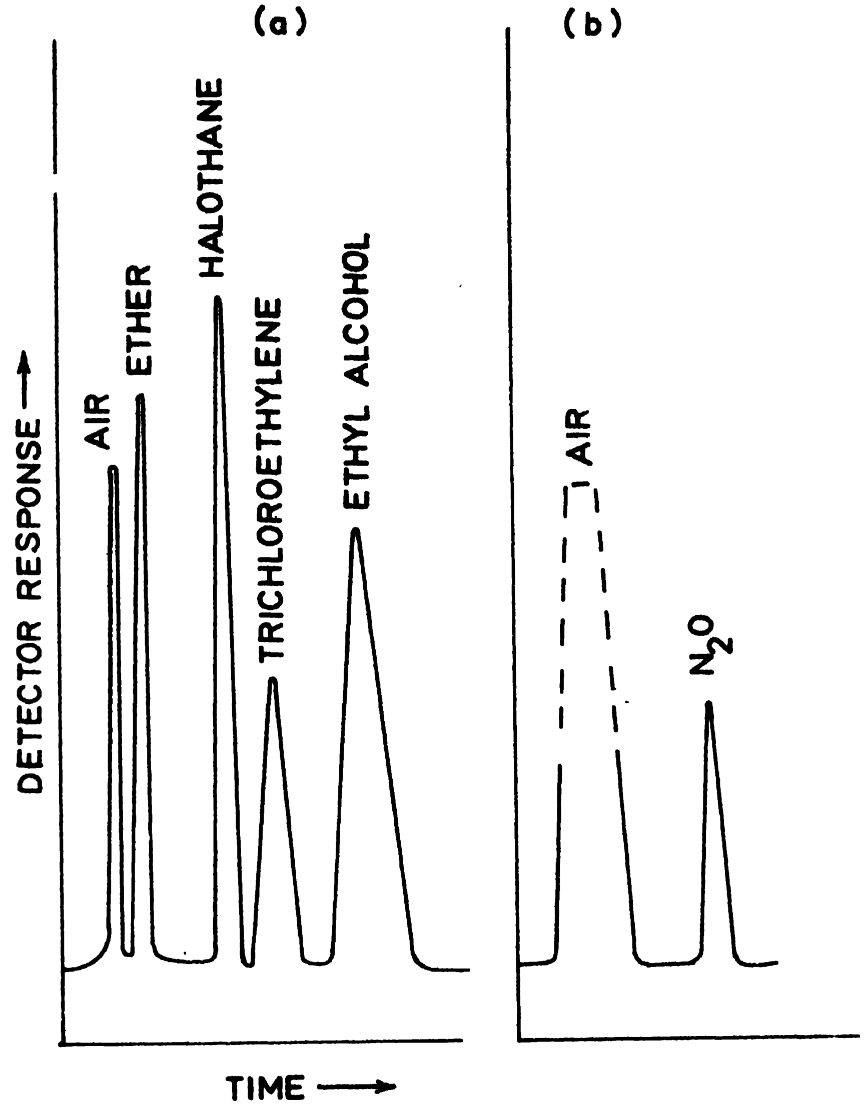


Fig. 3. Gas chromatograms of mixtures of air with anesthetic gases/vapours

Surveys of surgical environments

The recognition of pollution in operation theatres underlines the need for monitoring trace concentrations of the GIA vapours in surgical environments. Such data will be vital for the design and adoption of proper scavenging procedures to reduce pollution. Although some data on this have already been published in some foreign countries, no systematic effort seems to have been made in India in this direction. Among the different analytical techniques that can be made use of for such surveys, gas chromatography (GC) deserves special mention as its' sensitivity is very high and it offers the possibility of separating mixtures into individual components prior to estimation.

Ether, trichloroethylene (TCE), halothane (HAL) and nitrous oxide (N_2O) are four anesthetics commonly employed in hospitals in India. For monitoring low concentrations of ether and N_2O, flame ionization (FID) and thermal conductivity detectors (TCD) are the obvious choices. For estimating HAL, electron capture detector (ECD) is superior to FID. In case of ethyl chloride (which is also used occasionally) and TCE, flame ionization is more sensitive than electron capture. Schematic diagrams of the GC units incorporating these detectors are shown in Fig. 2.

Indian studies

As part of an International Atomic Energy Agency Project, gas chromatographic surveys of some GIA gases/vapours (ether, TCE, HAL and N_2O) have recently been carried out in the operation theatres of two hospitals in Bombay, by the Analytical Chemistry Division of Bhabha Atomic Research Centre. These are probably the first set of systematic data collected in our country on this aspect. Typical gas chromatograms are shown in Fig. 3.

In hospital No. 1 the concentration of HAL was monitored for several days. It was found to be around 1 ppm on several occasions, though values around 10 ppm could also be observed occasionally. In hospital No. 2, on the other hand, the maximum concentrations of all the four GIAs were found to be much higher (sometimes going even upto a few hundred ppm). These results suggest that the ventilation facilities of the first hospital are superior to those of the second. The absolute concentration of any GIA vapour in an operation theatre at any instant depends upon several factors such as location, duration and the rate at which anesthetic vapours are administered, duration and nature of operation, ventilation facilities, time of sampling, etc.

Even the limited data collected so far clearly show that the anesthetist and his supporting staff are exposed to much higher concentrations of the harmful vapours than the surgeon and his supporting staff.

In this context, the need for collection of such data through a comprehensive national survey cannot be overemphasized. They are vital (a) to understand the limitations of the ventilation systems in operation theatres of hospitals in our country, and (b) to redesign them, if necessary, to reduce the occupational hazards for operating room personnel. The Analytical Chemistry Division, at BARC plans to conduct a few more representative surveys in some more hospitals (urban as well as rural) in the country.

Pollution control

The occupational exposure to anesthetic gases can be reduced considerably if improved ventilation systems and scavenging devices are employed. Arrangements can be made, wherever possible, to connect the source of pollution with a suction system. Removal of a major portion of the harmful vapours by continuous circulation of the air (in the vicinity of the operating staff) through appropriate absorbing agents (like active charcoal) is also worth considering. Facilities must also be provided for (a) periodic monitoring of the operating theatres to assess the levels of the various anesthetic vapours, and (b) to take corrective measures when their concentrations exceed predetermined levels. This may also be useful in avoiding even a remote possibility of an explosion owing to accumulation of inflammable vapours (like ether) inside theatres. Sufficient time must also be given to operating room personnel for relaxation between successive operations. Finally, specifications concerning the quality of air in operating room environments must be fixed based on the information already available and every hospital must that [illegible] appropriate steps to maintain [illegible]ndards prescribed.

Other techniques used for inducing anesthesia

While discussing critically some of the adverse effects connected with chemical anesthesia, it would be interesting to mention briefly about techniques such as acupuncture, hypnotic analgesia, etc., which do not cause the type of pollution discussed above as they do not involve the use of chemicals. As these procedures are not yet fully understood they cannot be adopted for general use.

Acupuncture involves the insertion of hair-thin needles into specific sites of the body for the purpose of regulating physiological function and treatment of a variety of diseases. In the past 3000 years countless cases of various diseases have been treated in Asian countries by this technique. In China, acupuncture is now used along with Chinese and Western medicines to treat conditions as varied as peptic ulcer and schizophrenia. Needles and herbs are often used with success in place of surgery for acute abdominal conditions like appendicitis. The reported rate of success of acupuncture analgesia is 90%-95%. Proper patient selection and preparation are said to be crucial. The surgical team and the patient must carry out "ideologic and material preparation" in advance of the operation. Induction of analgesia takes usually 20-30 minutes.

Hypnosis is being increasingly used in modern medicine with excellent results. The American Society of Clinical Hypnosis has today a membership of about 2500. Primarily hypnosis calls for total relaxation of muscles and concentration. It has been said by experts that one is in a trance when one "concentrates". Hypnosis has been tried with success in dentistry, childbirth and even in major surgery. It appears that the master control glands in the brain alter the state of the body to such an extent that aches and pains, abdominal inflammations, drug addiction and hypertension can be beneficially treated and cured by the super power of mind.

The term psychosurgery baffles not only the common man but also the scientific community. But psychosurgical healers of the Philippines are known to have achieved remarkable success by this technique. Early this year, a French, Michel Carayon conducted operations on three persons in a sauna bath in Toulouse (France) before press and television cameras. The patients are reported to bear no traces of scars after the "operation." At this demonstration he extracted unidentifiable objects from the chests of two men and the abdomen of a woman by "squeezing the tissues." According to him, the substances which were malignant had "dematerialized" under the influence of physical vibration and had "reconstituted" themselves outside the body of the patient. No completely rational explanation for this technique is possible at this stage. One has to concede that medical knowledge, like any other knowledge, is by no means complete and new ideas are emerging even in the empirical West !

(Continued on page 604)

"Due to some defects in the arrangement, the surgeon too has imbibed a bit of the anesthesia."

TRITICALE— a man-made cereal

Triticale, a hybrid of wheat and rye, is a combination of high protein content of wheat and high lysine content of rye

KRISHAN MALIK

WHEN wheat (genus *Triticum*) and rye (genus *Secale*) are artificially crossed, the product is a hybrid that has characteristics of both. The hybrid is a new genus called triticale. The name is derived from a combination of two scientific names, i.e., '*Triti*' from *Triticum* and '*Cale*' from *Secale*. What makes triticale interesting is that it combines the high protein content of wheat with high lysine content of rye. With proper genetic manipulations it can also combine the high yield of wheat with ruggedness of rye. It is adaptable to unfavourable environmental conditions such as cold weather and soils that are light, sandy or acidic. Some advanced varieties of triticale appear to be more resistant to rust than wheat. This characteristic of the new hybrid inherited from its rye parents could prove to be one of its most important advantages because rust limits wheat production in many parts of the world. After years of research, triticale has become the first man-made cereal grain to compete successfully with the traditional cereals.

The pioneers

Dr. A. Muntzing of Sweden is among the leaders in triticale research. He spent 32 years in developing octaploid triticales, and in more recent years has also worked with hexaploids. Dr. Sanches Monge in Spain has spent much of his research efforts since 1952 in developing hexaploid triticales. Dr. A. Kiss and colleagues in Hungary worked on the development of both octaploid hexaploid triticales. In Japan, Dr. H. Kihara and co-workers contributed much to the basic knowledge about triticales. In America, limited work was done by Drs. J. G. O' Mara and E. R. Sears during the 1930's and 1940's. But the first triticale research and breeding programme undertaken in North America was in 1954 at the University of Manitoba (Canada) under the leadership of Dr. L. M. Shebeski. The project was

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led by Dr. B.C. Jenkins, subsequently by Dr. L.E. Evans and is currently led by Dr. E.N. Larter. In India pioneer workers in the field of triticale research are Dr. P.K. Gupta, of the Institute of Advanced Studies, Meerut University, Meerut and Dr. N.S. Sisodia, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur. Some other Agricultural Universities have also undertaken triticale improvement research programme.

Types of triticale

Wheat is an important member of the grass family (*Graminae*). It is classified into three groups according to the number of chromosomes in the cells. The wheat genome (complete inherited set of wheat genes) is carried by seven chromosomes. As each wheat plant receives at least one complete set of genes from each of its parents, its cells contain at least two sets of chromosomes. Many wheat species have more than two sets. *Triticum aegilopoides* (wild einkorn) and *Triticum monococcum* (einkorn) are diploid; they have 14 chromosomes and thus two genomes. *Triticum dicoccum* (emmer) and *Triticum durum* (hard or macaroni wheat) are tetraploid : they have 28 chromosomes and thus four genomes. The common bread wheats such as *Triticum aestivum*, *Triticum sphaerococcum* and *Triticum compactum* which account for most of the commercial wheat grown today are hexaploid : they have 42 chromosomes and so six genomes.

The rye genome can also be carried by seven chromosomes. The earliest known cultivation of rye was in the Balkan peninsula and eastern Europe. Although many wild relatives exist, only one cultivated species, *Secale cereale*, is recognized. It has 14 chromosomes (two genomes) and is therefore diploid.

Triticale can be produced in two forms : (1) Hexaploid triticale, and (2) Octaploid triticale. If a tetraploid wheat (*Triticum durum*, $2n=28$) is crossed with diploid rye (*Secale cereale*, $2n=14$), the result is hexaploid triticale. If hexaploid wheat (*Triticumaestivum*, $2n=42$) is crossed with rye the result is an octaploid triticale (Table 1).

Now, a question may be asked, why are all the F_1s (filial generations) infertile? The explanation is the presence of a single set of wheat chromosomes and a single set of rye chromosomes in F_1s. The two sets of chromosomes cannot pair for the

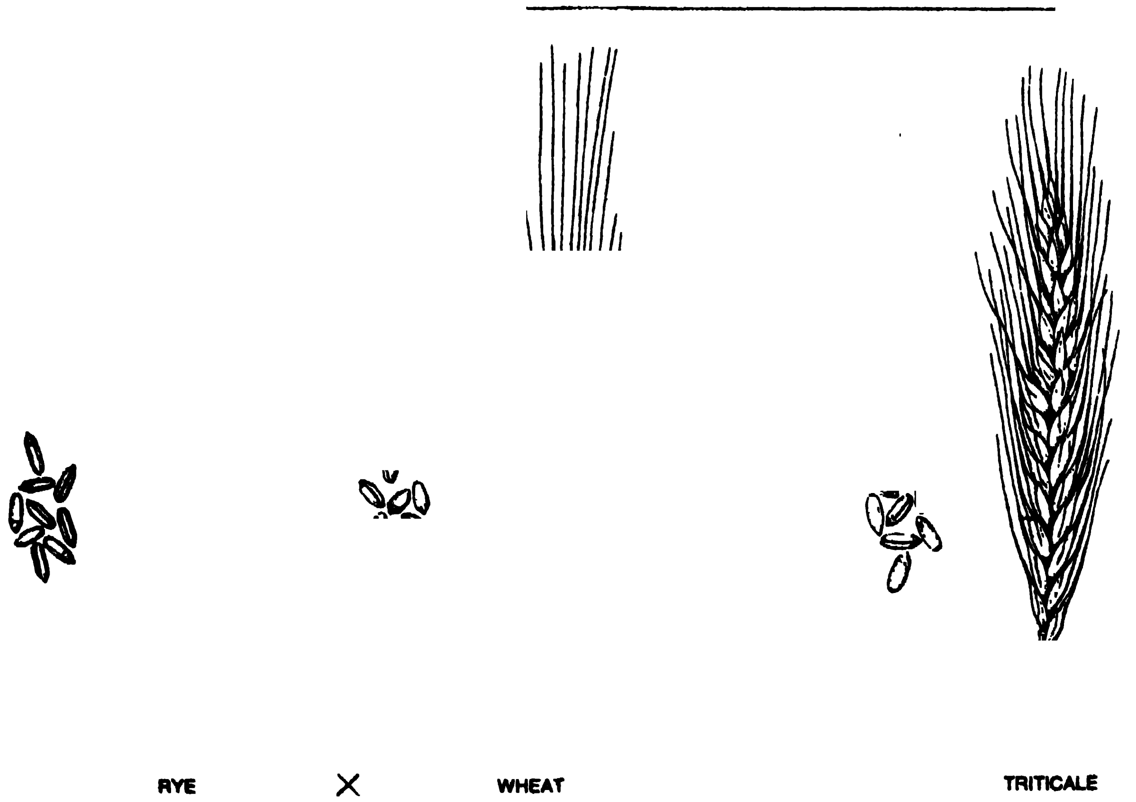

Fig. 1. How triticale is created by cross-breeding

purpose of sexual reproduction, and cannot produce offspring. When the chemical colchicine is applied to the triticale seedling, the set of chromosomes is often doubled. It becomes possible for wheat chromosomes to pair with wheat chromosomes and rye with rye; such a plant is fertile.

Another important factor in the development of triticale is the technique of embryo culture. Because of the genetic incompatibility of the parent species, the hybrid embryos do not always develop normally. Their chances of survival can be increased by removing the embryo from the seed between 10-21 days after pollination and transferring it to an agar gel containing inorganic salts, other nutrients and sometimes plant growth hormones. The cultured embryo is kept in the dark until roots begin to appear. Then it is allowed to grow in light under constant illumination. When shoots develop, the plant is potted in soil. When the hybrid plant has produced several shoots, it is treated with colchicine.

Both from cytogenetical and breeding points of view, the octaploid triticales are unstable and have varying degrees of sterility which have been primarily responsible for its poor adoption. In recent years, triticale breeders all over the world, particularly in Canada, Hungary and the U.S.A. have been concentrating on hexaploid triticales, which are agronomically more promising. They can be primary or secondary types depending upon their derivation. The method of producing primary hexaploids has been explained earlier. The secondary hexaploids are derived from either 6x wheat×6x triticale or 8x triticale×6x triticale. It has been suggested that the secondary hexaploid triticales are likely to be more fertile and agronomically well adapted. This is possibly because these two hybrids differ at nuclear as well as cytoplasmic level. More emphasis has been given on the improvement of secondary hexaploid triticales due to their superiority over primary hexaploid triticales in respect to cytological stability and fertility.

Both octaploid triticales and secondary triticales have been found to have some drawbacks such as chromosomal instability, various degrees of sterility, rough shrunken seeds, tall luxuriant growth and poor *chapati* and bread-making quality as compared with the bread wheat. But they have some desirable characters which make them a good substitute of present day wheat. Among them are large ear size, more grains, resistance to draught and frost and higher content of better quality of protein as compared to the bread wheat (18%-20% protein with 2.69% to 3.69% lysine content). Because of its high yield, triticale is a good substitute of wheat in dry farming areas also.

Triticale improvement in India

The basic problem with triticale is its cytological instability. Long ago, it became clear that partial sterility in triticale is only a consequence of meiotic disturbances. But a Swedish geneticist Merker (1971) suggested that some other genetic or cytoplasmic factors are also involved which have harmful physiological effects on the development of reproductive apparatus. In some triticales, the anthers are poorly developed and shed pollens with difficulty.

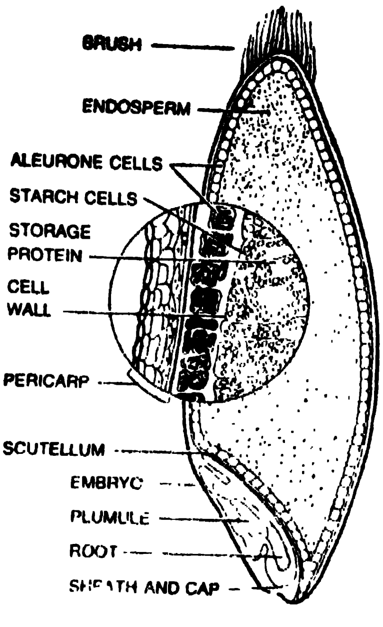

Fig 2. Triticale kernel

Table I

1. *Triticum durum*	X	Rye (*Secale cereale*)
$2n=28$ (AABB)	↓	$2n=14$ (RR)
$4x=28$		$n=7$
$n=14=2x=14$		$x=7$
F_1 2n	=	$8x=21$ (ABR) infertile, colchicine treatment for doubling of chromosomes
	↓	$6x=42$ (Hexaploid triticale) $2n=42$ (AABBRR) (Fertile)
2. *Triticum aestivum*	X	Rye (*Secale cereale*)
$2n=42$ (AABBDD)	↓	$2n=14$ (RR)
$6x=42$		$n=7$
$n=3x=21$		$x=7$
F_1 2n	=	$4x=28$ (ABDR) infertile, colchicine treatment for doubling of chromosomes
	↓	$8x=56$ (Octaploid triticale) $2n=56$ (AABBDDRR) (Fertile)

It was also observed in some strains that seeds are only, or mainly, produced in proximal part of ears and not in the distal part. But the main problem is the disharmony between wheat and rye genomes. Considerable research has been done in India on these problems.

Shrivastava and Malik of the Institute of Advanced Studies, Meerut University reported in 1974 that when 6x triticales are treated with 0.15% E.M.S. and irradiated with gamma rays, there is an improvement in the pollen viability, seed setting and kernel weight. The percentage of meiotic irregular cells is also reduced. They suggested that the cytological stability and kernel weight could be further improved by progressive selection in the progeny of mutants.

Gupta *et al* of Indian Agricultural Research Institute, New Delhi reported 5 to 100 per cent seed setting in the crosses of wheat with rye. The seeds having well developed embryos were selected for culture using x-ray screening technique. They suggested that more than 50% survival can be obtained by this technique.

Kempanna and Seetharam of the Institute of Agricultural Sciences, Bangalore, studied the meiotic stability and seed fertility in 80 hexaploid triticale lines and found considerable variation for all the three characters. There was no correlation of meiotic irregularity either with pollen fertility or withseed fertility. The pollen fertility and seed fertility were also not related.

Scope for potentiality in India

In India cereals provide 70% to 80% of the total calories and more than 60% of the protein in the diet of the people. The remainder of the protein is usually provided by legumes. of the cereals, wheat is the most popular because of its good bread-making quality. Triticale grains contain more protein than wheat. The quality of protein in triticale is also superior to that of wheat in terms of higher lysine content. Therefore, due to its higher nutritional value, this new cereal holds considerable promise for India. It can also provide a solution to our protein problem.

Wheat cannot be grown properly in areas which do not have irrigation facilities. In such areas, triticale can be a substitute crop for wheat, because of its drought resistant ability. It can also be grown successfully in the hilly areas.

Although there has been considerable progress, there are still problems to be solved. The shrivelling of triticale grains, for example. Its incidence is now significantly lower than before but has not yet totally been overcome. Strains with meiotic stability, disease resistance, unshrivelled endosperm and with broader adaptability are being developed. The time may not be far when triticale will be able to replace wheat because of its nutritional qualities.

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CORRIGENDUM

In the article **The World of Primes** (*SR*, August 77) Pp, 499, to 502, following are the errors:

On page 500, column 1, line 17 from bottom, *read* 200 *for* 209; column 2, Eqn. 1 is $b \geqq a$; column 3 *read* L. Eueler (1707-1783) for L. Euler (1707-178 A.D.). On page 501, column 3, line 4 from bottom is $n=(2^p-1)\,2^{p-1}$. On page 502, column 1, in 12th and 13th line from bottom *read* $x/\log_e x$ *for* $x/\log x_e$.

COPPER IN ANTIQUITY

N. HARINARAYANA

The history of copper goes back to 4th millenium B.C. in Indus Valley and Egypt. It is one of the earliest metals to have come into use

A little reflection would bring home to us the vital role that metals play in our daily life—directly or indirectly—at a time when new synthetic materials have been creat-

How exciting, rapturous must have been the time when man first stumbled upon the true nature of metals as opposed to stone which was till then his chief material for making tools and weapons! Stone is no doubt strong, hard and durable but it is brittle and chips off. It lacks the toughness of a metal. When properly produced, a metal withstands use and abuse far better than a stone. Thus it was really a remarkable breakthrough.

If we study the course of the development of the use of metals, we find that three metals—gold, silver and copper—were the earliest to come into use. In the Periodic Table of chemical elements, these three metals belong to the same subgroup which signifies that they have some chemical properties in common. The most important of them is that they are the only metals to occur in free state in nature. In fact this may be the reason for their early discovery. Of the three, copper is more rare in free state than the other two. But it is not known which of them was recognised and used first. Gold and copper vie for this honour, and though gold occurs more widely in free state and is most likely to have been discovered earlier, copper objects of the greatest antiquity have been found. Copper beads found in Northern Iraq dates back to the beginning of the ninth millenium B.C. No gold object of comparable antiquity has been found.

It has been established now that copper had been fairly known to the ancients and was in use by 4th millenium B.C. mainly in Sumeria, Mesopotamia, the Indus Valley and Egypt. Around the Great Lake Region of North America, the Red Indians used copper 4,000 years ago. Copper in free state was probably found in and around these regions.

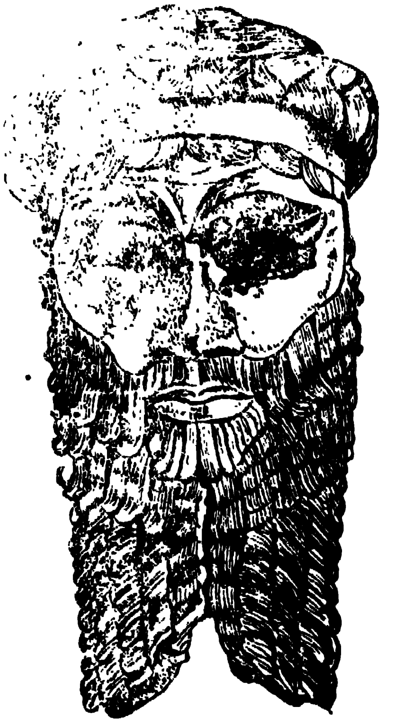

Fig. 1. **Bronze head of Sargon the Great of Akkad, Nineveh, Mesopotamia (2250 B.C.). The earliest surviving life-sized bust in cast bronze**

Shri Harinarayana is Curator, Government Museum, Madras.

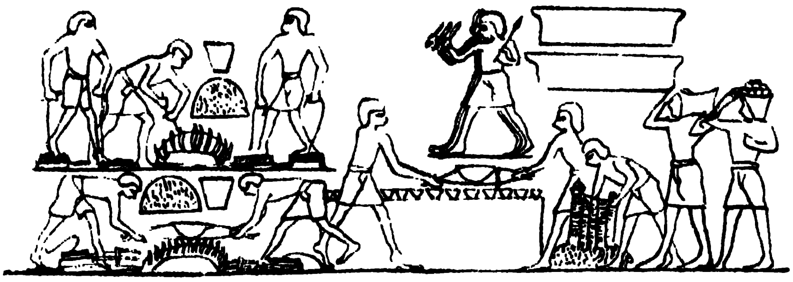

Fig. 2. Casting a bronze door. From a tomb at Thebes (c. 1500 B.C.)

The earliest method of obtaining copper was by washing alluvial deposits. But it was not long before man discovered that certain 'stones' when heated or roasted with charcoal yielded the metal. This was a momentous discovery, for it opened up the possibilities of getting the metal in large quantities. A measure of its production can be had from the reported estimate that in ancient Egypt approximately 10,000 tons were produced in 1500 years. In the Eastern Alps, the amount said to have been produced between 1300 and 800 B.C. was 20,000 tons.

"The most important copper ore deposits of remoter antiquity were in Sinai, Syria, Baluchistan and Afghanistan, Caucasia and Trans-Caucasia, the Taurus region, Cyprus, Macedonia, Iberia and Central Europe", says Prof. R. J. Forbes, the well-known historian of science. Archaeological evidence of copper ore mining has been found in Sinai. "Miners' huts, temples, fortified camps and heaps of waste mark the sites". Similar evidence of copper mining in Singhbhum and Hazaribagh districts in Bihar and in Rajasthan has been mentioned by Acharya P. C. Ray, the great Indian chemist of our times. "The Indus Valley copper most likely came from the Indian ores in the Rajputana District and Baluchistan", he says. It is interesting to note the description of copper ores found in Kautilya's *Arthasastra* (4th century B.C.). It says "these are obtained from plains or slopes of mountains. They are heavy, greasy, soft, tawny, green, dark, bluish yellow (*harita*), pale red or red".

Smelting of the ore was an operation which required skill. Acharya P. C. Ray describes a process of extracting copper used in Rajasthan as late as the 19th century which is supposed to have been employed by the early copper miners. In this method, a hollow is dug in the ground and alternate heaps of ore and charcoal are piled above it. Provision is made for blowing air into the pile and for molten metal to run out. The yield in such an operation was only 2½% to 7½%. Low yields and crudely-produced copper in the initial smelting were also characteristic of the other copper-producing centres of the ancient world.

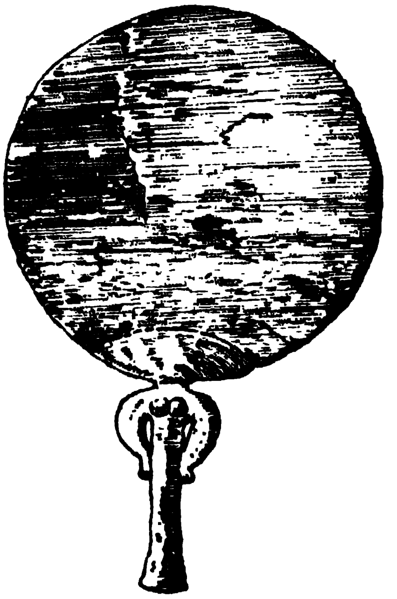

Fig. 3. Copper mirror, 5 inches in diameter, with the handle in the form of a stylized female figure from the Mehi site in Baluchistan.

At this point, it may be mentioned that copper alloys appeared early in the history of copper metallurgy. The earliest copper alloys might have been accidentally obtained because of the presence of other metals in the ores themselves. But, in due course, the superiority of copper alloy over pure copper was recognized.

Pure copper is soft and does not respond well to heat treatment. It melts at 1083 °C which is quite a high temperature. When casting technique was developed, it was found that pure copper does not give a well-finished cast. Bubbles of air get trapped in it and blow-holes result when the molten metal solidifies. Copper alloys on the other hand are harder, melt at a lower temperature (about 800 °C), and cast well. The Indus Valley civilization was one of the earliest to produce bronze, the most widely used copper alloy. The alloying metals used were tin, arsenic and lead. Zinc came later and gave rise to brass. The wide fluctuations in the percentages of tin in the alloys found in copper objects from various places show that much of the tin came into the alloy without any control. The alloy might have been prepared by roasting together ores of copper and tin. Generally the tin content varied between 5% and 20%.

The process of preparing tin separately and adding it to copper in required quantities to get bronze with the desired composition and properties dates back to 1500 B.C. Many ancient bronzes contain appreciable quantities of arsenic. Arsenic makes bronze quite hard, but sometimes brittle too. Such arsenic alloys give good castings. "The zinc sometimes found in ancient bronzes was never added to the copper as such, for zinc was quite unknown throughout antiquity." The Indus Valley people are said to have known four distinct varieties of copper and its alloys: (a) crude copper, (b) refined copper, (c) copper-tin alloy or bronze, and (d) copper-arsenic and copper-arsenic-lead alloys.

What emerges from a study of ancient objects is that most technical processes employed during the long history of metal working had already been invented before 2500 B.C. Processes such as annealing, moulding, casting, rivetting, soldering, brazing, etc., were known.

The earliest copper objects were produced by cold working, that is, by hammering in the cold. This limits the possibilities of design as well as the strength achieved. Heating the metal and then shaping it with hammer blows was found to be a better technique. Still later, it was discovered that alternate heating and cooling makes the metal tougher. This process, called annealing, is used to toughen steel also.

Although shaping by hammering was useful, it could not produce rounded forms. For this one had to wait until moulding and casting were invented. One of the most interesting processes of casting was the *cire-perdue* method which was perfected in India and widely employed. In the process, the object to be cast was prepared in wax and the mould shaped round this in clay and dried. Then the wax was melted away and the molten metal poured in. After cooling the clay mould was broken and the cast taken out. All our celebrated bronzes were prepared by this process. The process is used even today for this type of work.

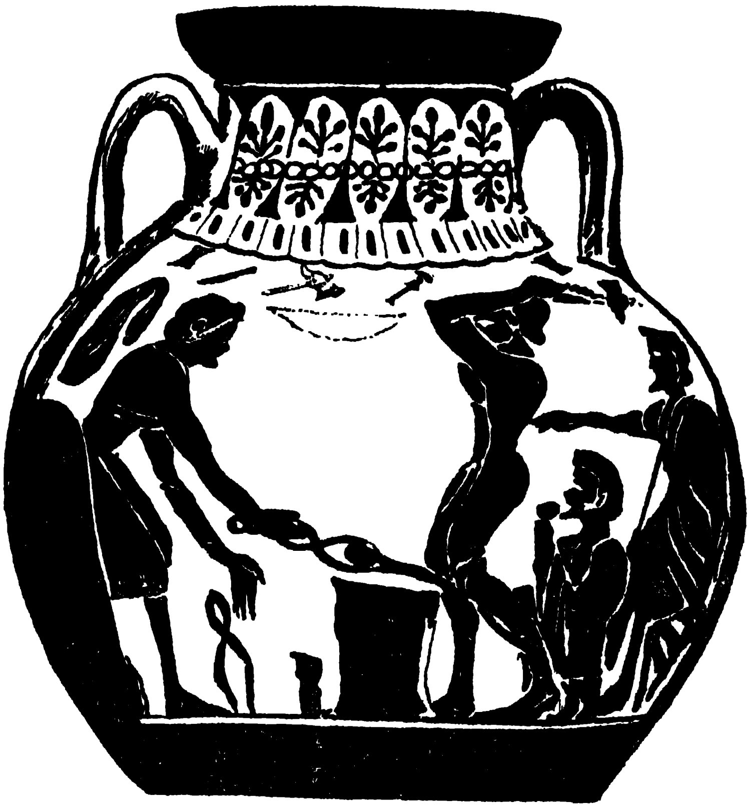

Fig. 4. Forge pictured on an Athenian amphora, Sixth Century B.C.

"But why this love for copper when I can easily be a gold digger?"

Now let us turn to the uses to which these discoveries were put from the beginning. Some authors say warfare was the prime motive force for metal development. More than anything else perhaps, it stimulated the demand for metal. It does not matter much if a flint knife breaks while skinning an animal. It is a much more serious matter if the accident happens in a hand-to hand combat with an enemy. It was battle, above all, that manifested the superiority of tough, durable copper or bronze over brittle flint and stone. Thus we have daggers, battle axes and arrow heads among the earliest copper and bronze objects. Then we have the Bronze Age tools: hammer, anvil, Celt axe, chisel, drill and files. But even in these purely utilitarian objects, art and design began to manifest itself. Using the different techniques available, daggers and battle axes came to be decorated especially when they were made for the royalty and nobility. Copper and bronze were used for other purposes as well: domestic utensils, statuettes, bangles, rings, ear-rings and anklets. In fact, when iron was still a new metal and rare, it was used to decorate copper ornaments and objects!

The Indian achievement in ancient copper technology is impressive. The Indus Valley produced an excellent range of copper and bronze objects, the most celebrated of which is the Bronze Dancer, now in the National

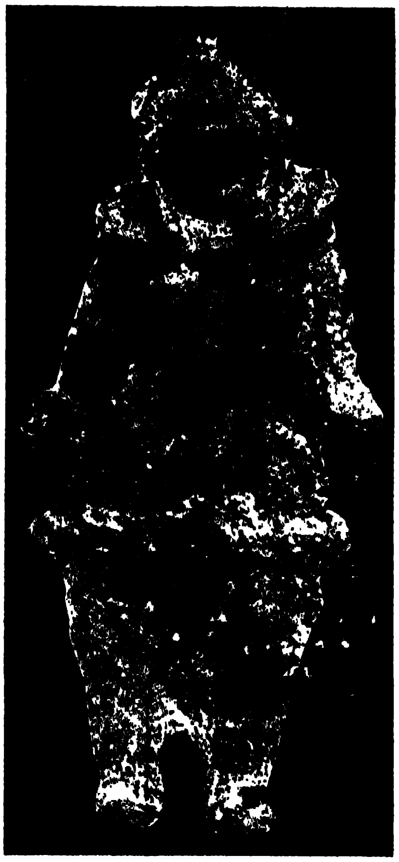

Fig. 5. Bronze figure from Adichanallur (Government Museum, Madras)

Museum at New Delhi. Grants given on copper plates is a characteristic Indian application. Acharya P. C. Ray mentions the Sohgaura copper plate as dating from 3rd century B.C. The bronze articles from Adichanallur in Tirunelveli District are fine specimens of early copper objects. Hieuen Tsang, the Chinese traveller, has left a description of a colossal copper statue of Buddha about 24m in height which he found standing near the famous Nalanda Convent in Bihar. He also refers to an unfinished "*Vihara*", all of brass, which Raja Siladitya had projected near Nalanda. If finished, it would have measured about 30.5m.

The Taxila excavations have yielded bronze and brass objects dating from 5th century B.C. to 6th century A.D. A copper mirror from Kulli, a Harappan site, is a beautiful example of design and technique. It consists of a round mirror with the stylised torso of a woman forming the handle. Of the later day Indian objects of copper and its alloys, South Indian bronzes have won unique acclaim as artistic masterpieces. The earliest of these now in the Government Museum, Madras is a figure of the Buddha from Amravati near Guntur in Andhra Pradesh dated to 4th century A.D. The bronze images of the Pallava and Chola periods are considered the acme of the achievement of South Indian sculptors in metal.

It is not only the metal copper but its compounds were also known and used in ancient India—especially in medicine. The ancient texts reveal sound knowledge of the chemistry of copper. Acharya P. C. Ray quotes the following ancient prescription: "Take a thin leaf of Nepalese copper and embed it in powdered sulphur. The substances are to be placed inside a saucer-shaped earthernware vessel and covered with another. The rims are lubed with sugar or powdered rice paste. The apparatus is heated in a sand bath for three hours. The copper thus prepared is powdered and administered with other drugs." The product of the reaction is obviously a sulphide of copper. The following extract from *Rasarnava*, another ancient text, shows a good knowledge of metal corrosion: "O Goddess! listen now to what I say about the metals. Gold, silver, copper, iron, tin and lead, these are the six metals and their resistance to waste (i. e., corrosion) is in the order in which they have been named".

These glimpses of copper in antiquity show what a metal it was! No wonder one epoch of human history has come to be called "the Copper Bronze Age".

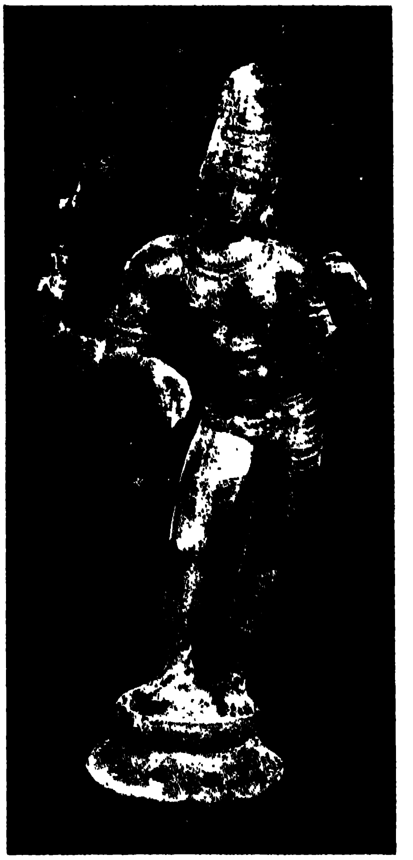

Fig. 6. Ardhanareeswara image. Chola bronze from Thiruvengudu, Tanjore District, Tamil Nadu (11th Century A.D.) (Government Museum, Madras)

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(*Continued on page* 588)

SCIENCE SPECTRUM

What are exoelectrons?

EXOELECTRON is not one of the recently discovered elementary particles. 'Exo' is merely a suffix to mean 'emitting'. Exoelectrons are electrons emitted when energy, in some manner, materialises in a freshly prepared metal surface. Abrade or polish a surface, and it will emit exoelectrons for some time.

Easy though the production of exoelectrons may appear, they were discovered only after Geiger tubes came into use. Geiger tube is a cylindrical metal tube surrounding a thin metal rod. A high voltage is applied between the two, one acting as cathode and the other as anode. This system is housed in a case which has a quartz window that faces the source whose radioactivity rate is to be counted. Whenever radiation, in particular electron, enters the tube, it ionises the air gap in-between the cathode and anode allowing a "pulse" of current to pass through. The current pulse is noted by a counting mechanism and in this way the radioactivity rate of the source is determined.

In 1940s Johannes Kramer, a physicist, observed that any newly machined part in Geiger tube produced erratic counting rates for a few hours to a few days before returning to its normal performance. After much study, he concluded that all freshly prepared metal surfaces gave off electrons which caused the counting rate to vary in the beginning; the normal performance returned as soon as the emission of exoelectrons stopped. He believed that heat produced in some way was the cause of liberation of these electrons. But neither he nor later physicists could say precisely how energy comes into play in a freshly prepared surface and exoelectrons get liberated. Each believed in a particular set of favourable circumstances.

Everyone knows that when a body is heated electrons are emitted. Thermal energy is imparted to electrons so that they break loose from their atoms and fly away. Electrons are also emitted by a surface when any radiation, say, ultraviolet, strikes it. Again, high-energy photons of the radiation are absorbed by electrons to become energetic enough to leave their respective atoms. In short, electrons need an outside source for their emission from a surface. The minimum energy required for an electron just to get "detached" from the atom, let alone for their emission (which means possessing kinetic energy too), is called the work function. The value of this quantity depends upon the kind of the surface. In copper, for instance, the work function of an electron is 4.3 eV. That means to get emitted from a copper surface an electron needs more than 4.3 eV of energy. From where does the electron get the energy when the surface is freshly prepared?

All the circumstances favourable for the liberation of the required energy are yet unknown; only two are worthy of attention at present. One is the chemical bond energy. Every solid has a crystalline lattice structure in which bonds connect molecules or atoms in a regular pattern. When its surface is, say, machined, the upper layer of crystal structure gets disturbed. Atoms are let loose, bonds are left dangling. When the atoms rearrange. compromising with whatever bonds they get their hands on, to form structures, bond energy is let loose which materialises into exoelectrons. The second cause is oxidation. The freshly prepared surface, when exposed to air, gets oxidized liberating chemical energy in the form of heat. This heat brings about the emission of exoelectrons.

Whatever may be the causes, it has now been realised that the production of exoelectrons is a rare event, say, one atom in ten million freshly exposed atoms produces an exoelectron. Moreover, this is subject to favourable circumstances.

Applications

The phenomenon of exoelectron production could be made use of in many engineering problems, where even the latest techniques such as optical microscopy, electron microscopy, scanning electron microscopy, autoradiography which are employed for 'looking' into metals, fail. For instance, there is no sure method of determining the crack growth in rolling contact devices, fatigue wear, etc. As any crack developed due to continuous rolling or bending or friction would be a freshly "prepared" surface, it would emit exoelectrons. So from the detection and measurement of these electrons, many incipient flaws in an engineering design or system, which led eventually to its failure, could be checked. The scientific study of crack growth, fatigue, corrosion, etc., could also be done and proper precaution taken or modification in design or system could be made (*Scientific American*, Jan 1977).

The latest innovation in this technique is to scan the object under test by using an ultraviolet beam. Of course, the energy of such a beam should necessarily be less than the work function of the material. The result is that instead of a few exoelectrons, a large number of them get emitted.

It follows that any radiation incident upon freshly prepared surface would enhance the exoelectron emission. So this effect could also be used in monitoring radiation damage. The advantage this technique has over the present ones is its cheapness and reusability. Research in this application of exoelectrons has been rigorously taken up in recent times as the prevention of radiation hazards in nuclear plants has assumed tremendous importance in this nuclear age. Anyway, time is not far away when exoelectron technique will within minutes scan the entire wing structure of an aeroplane or rails or wheels of the fast trains for an incipient flaw which can later cause much damage. It may even help in the prediction of earthquakes from studying the cracks in the surface of the earth crust, etc.

DILIP M. SALWI

The case of the missing sunspots

SUNSPOTS, the occasional dark patches that are seen on the face of the sun, have been known for centuries and are among the best documented facts in astronomy. Early observations were mostly made with unaided eye. In 1911, for the first time Galileo used his telescope to study them. Since then sunspots have been under continuous telescopic scrutiny.

It was known for a long time that the number of the spots is not constant. It varies from year to year. In 1843, the German astronomer, Heinrich Schwabe made a remarkable discovery after a seventeen-year study of the spots. He found that their number shows a regular periodicity of about 10 years. Later observers confirmed Schwabe's findings, but they found the average period to be 11.2 years. Soon it was discovered that the sunspot cycle is associated with other signs of solar activity, like flares, and with recurring terrestrial effects such as the brilliant auroral displays. The sunspots were even thought to be linked to climatic changes on earth.

Few at that time doubted the constancy of the 11-year cycle. In fact, it was accepted as evidence of the regularity of solar activity. The sun was considered to be constant and predictable. But is it really so?

In 1893, E. Walter Maunder, Superintendent of the Solar Division of the Royal Observatory of Greenwich, England, noticed an unusual discrepancy. While searching through some old books and journals he found to his great surprise that for a period of 70 years, from 1645 to 1715 A.D., there were almost no spots on the sun! For some 32 years during that period not a single spot had been sighted. In fact, the total number of sunspots reported between 1645 and 1715 was less than what is seen in a single average year today.

What happened during those 70 years? Were the old records correct? Did the sun really become quiet? To find out, Harvard astronomer John A. Eddy scanned through all available sunspot records and checked and cross-checked them with contemporary accounts of auroras, solar eclipses and other related phenomena. Study of carbon-14 content of old tree rings also gave valuable clues. And all these led to the same conclusion: the sun was indeed quieter during those 70 years (*Scientific American*, May 1977). During that period, the brilliant solar corona normally seen during a total eclipse, was totally absent. The magnetic storms and auroral displays that are common in the higher latitudes virtually disappeared. Finally, the sunspot-minimum period corresponds almost precisely with an unusually cold wave during the "little ice age" that swept through Europe from the 16th to early 19th century.

Surprisingly, after 1715 the sunspot cycle has remained almost constant. But it seems likely that it is only a transient phase. May be, the present period is an unusually active one !

BIMAN BASU

The earth is getting warmer

THE Scientific Committee on Problems of Environment (SCOPE), an international body which met at Ratzeberg, West Germany, in March this year has taken a serious view of the growing menace of increasing amount of carbon dioxide in the atmosphere.

Dr. Pandya, of Saurashtra University, was the only scientist from India to attend the meeting. According to him, the increase in the carbon dioxide may threaten life on earth and may also cause a gradual increase in global temperature. He said that the increase is due to burning of fossil fuels like coal and oil, and agricultural practices with the consequent increase in the decomposition rate of humus.

Dry air consists of 78.03 per cent nitrogen, 20.99 per cent oxygen, 0.94 per cent argon, 0.025 per cent carbon dioxide. The rest is made up of neon, helium, xenon and hydrogen.

Carbon dioxide is a combustion product of the three billion tonnes of coal and 13 billion barrels of oil the world burns every year. Most of it escapes into the atmosphere.

Aeons ago carbon dioxide came into play with the appearance of green plants. They inhaled carbon dioxide from the atmosphere and in the presence of water, sunlight and chlorophyll converted it into carbohydrate food by a process known as photosynthesis. Human beings and animals eat them, burn up carbohydrates to obtain energy and in doing so give back carbon dioxide to the atmosphere, by a process known as respiration.

Oceans dissolve carbon dioxide and turn it into carbonates that serve as shells for clams, oysters and other shellfish. Rain also removes carbon dioxide in atmosphere by dissolving and forming carbonic acid.

Nature's well designed carbon dioxide cycle has long maintained a happy balance of this gas in the air we breathe. But with rapid industrialisation we have upset this neat plan. With our factories, autos, airplanes, etc., belching a never ending stream of carbon dioxide into the air, Nature has been unable to absorb the increase. Consequently, the percentage of carbon dioxide in the atmosphere is slowly, but surely increasing.

Several years ago, Dr. Gilbert Plass, a scientist and expert on atmospheric physics, warned that this increase in carbon dioxide content will have a profound effect on our climate. The basis of the scientist's alarm is the fact that carbon dioxide acts like glass windows in a greenhouse, allowing warm rays of the sun to pass in but at the same time holding back the heat radiated by earth. Carbon dioxide molecules are transparent to sunlight but not to the heat radiation. So they trap and reinforce the solar heating effect and cause what is popularly known as "Greenhouse effect."

As the amount of carbon dioxide increases more heat will be retained by earth's surface and the climate will gradually get warmer. Scientists have calculated that we are increasing carbon dioxide concentration by nearly 30 per cent each century, and that this would produce an average rise in temperature of 1 degree Celsius in 100 years. Significantly, this figure corresponds almost exactly to the rate at which the earth's temperature has actually risen since 1900 A.D.

One reason why carbon dioxide content is rising is that oceans that dissolve the gas are now saturated and are loosing their capacity to dissolve more of it. The other reason is that more coal and oil are being burnt every year. It is believed that an increase of 4°C would completely melt the polar ice caps, and the melted ice would flood many populous and picturesque areas. This is also the view of scientists from 66 nations who studied the earth during International Geophysical Year. These findings confirm the fact that the world's climate is becoming warmer due to greater quantities of carbon dioxide being fed into the atmosphere. The latest measurement of global atmospheric carbon dioxide taken in 1971 showed 0.032 per cent of it.

According to Dr. Pandya, man will have to retreat from the cities and live under water for protection from the high temperature created by the increase of carbon dioxide. He said the present increase in heart diseases, skin cancer, and the metabolic changes leading to diabetes were mainly due to carbon dioxide increase.

The meeting recommended that immediate steps should be taken to cut down the air pollution from industries. Rapid afforestation may also help.

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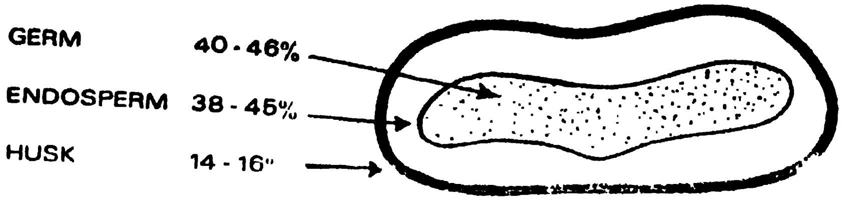
Guar gum

GUAR, *Cyamopsis tetragonolobus* is a leguminous plant which has been grown in India for thousands of years but was valued only as a feed for animals and as a cheap vegetable for the poor. Today the gum obtained from its seeds is a vital processing chemical for paper, mining, food and pharmaceutical industries.

Considering the newer developments in the utilisation of guar gum, the plant has a role to play in the economic development of arid areas of Rajasthan. According to statistical reports of 1972-73, guar was cultivated in 1,184,000 hectares in India; 460,000 tonnes of guar seeds were produced.



Guar is grown in western arid and semi-arid parts of India. It is a robust bushy plant and tolerates moderate salinity. The main stem and branches of the plant bear pods (which resemble soya bean) containing upto ten seeds.

The guar seed is made up of 40%-46% germ, 38%-45% endosperm and 14%-16% husk. The endosperm of the seed is the source of guar gum. The guar gum became commercially important during World War II when the supply of locust bean gum, the traditional raw material for American paper industry, was adversely affected. The manufacturers utilised guar gum as a possible substitute. The gum was first produced in commercial quantity in 1950 by an American firm. Thereafter, a number of commercial preparations have been made available in the world market under different names. A large number of small industrial units in north-western India are processing guar seed for separating the crude gum, which is exported as such, while the germ is used as animal feed.

Manufacture and purification of guar gum

Separation of guar gum from the seed is based on differential grinding; the hard endosperm (guar split) is easily separated from the hull (loosened by flaming) and germ by milling and air-sifting The decorticated, vitreous looking endosperm is finally ground to the powder of required mesh size. The free flowing whitish powder can be kept in dry form indefinitely with the help of added preservatives.

Viscosity is often taken as a common denominator and performance index in comparing different grades of guar gum. The most important property of guar gum is its ability to hydrate rapidly in cold water systems to give highly viscous solutions. A 1% aqueous dispersion of a good quality guar gum has a viscosity of 3000 cps–6000 cps.

Composition and structure

Guar gum is a polysaccharide consisting of a complex carbohydrate polymer galactose and mannose and is chemically classified as galactomannan. It also contains some pentoses and traces of proteinaceous matter. The absence of uronic acid differentiates this polysaccharide from a great majority of plant gums and mucilages. A typical analysis of a commercial guar gum is as follows :

Galactomannan	78%—82%
Water	10%—13%
Protein	4%—5%
Crude fiber	1.5%—2.0%
Ash	0.5%—0.9%
Ether extractables (fat)	0.5%—0.75%

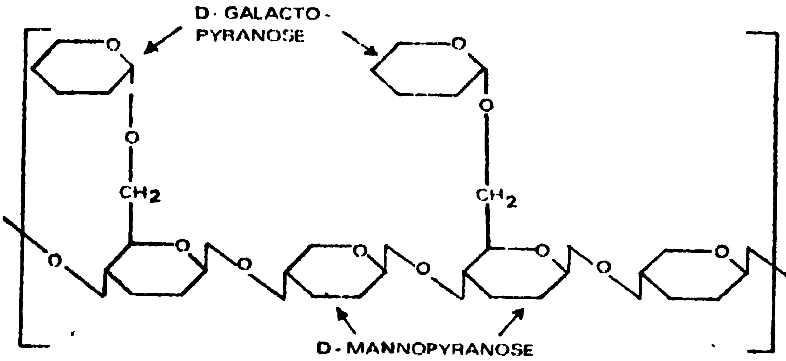
The chemical structure of galactomannan has been the subject of extensive studies using chemical hydrolysis, selective enzymatic hydrolysis and also physical methods such as optical rotation, infrared spectroscopy, stress-strain measurements and x-ray analysis. It is composed basically of a straight chain of *D*-mannose units linked together by (1-4) glycosidic linkages every alternate mannose and a single *D*-galactose joined by a (1-6) glycoside linkage. It has a molecular weight of the order of 220,000.

Industrial applications

Food industry. Guar gum is widely used in salad dressing, ice creams, lollipops and sherbats, in bakery products and confectionery, meats and sausages, cheese spread and in many other applications. It is used as a thickener in salad where it raises viscosity and decreases separation rate. Its ability to bind water permits it to be used as a stabilizer in frozen foods, cheeses, and icings.

Pharmaceutical industry. In the pharmaceutical industry, dry guar gum is used as a disintegrant and in solutions as a binder in compressed tablet manufacture. It is also used in dietary preparations as a low calorie thickener to improve their mouth feel and pour characteristics. On account of hydrophilic properties and the ability to form gel-like mass it is used as appetite depressants, as a bulking agent in laxatives and in gastric ulcer treatment.

Mining industry. Guar gum as a hydrocolloid finds use as a depressant for slimes or gangue, resulting in a high recovery of purified ore. It can also act as a flocculant or a settling aid to concentrate the slimes



for easy disposal and recovery of water for reuse.

Paper industry. The largest use of guar gum is in paper industry which consumes about 50 per cent of its production. Guar gum is added to the pulp before sheet is formed on the machine. It acts as an excellent beater additive and breaks up agglomerated cellulose pulp and disperses them uniformly in the pulp slurry, thus ensuring a more regular distribution of pulp fibre throughout the sheet. This results in increased burst strength and tensile strength.

Textile industry. Solutions of most guar gum grades can be dried to form flexible films which resist most organic solvents, but which readily dissolve in water or aqueous solutions. Textile sizings, for instance, use such temporary films for protection of fibres during the weaving process. Some derivatives produce water resistant films, guar triacetate being the most prominent example. It also serves as a pigment dispersing aid, and above all as a thickening agent for colour printing pastes.

Cosmetics. Guar gum is used in the manufacture of tooth-paste to which it imparts slip so that the paste can be extruded from the tube by gentle pressure. It is also used in the manufacture of shaving creams, hand lotions and washable creams.

It has also miscellaneous uses as a thickner for battery electrolyte, printing inks and as an ingredient in paints, adhesives and polishes.

Chemical modification

Various chemical treatments have been developed to modify the physical properties of guar gum to make it versatile and useful in industrial applications. The modification involves oxidation, esterification and etherification of hydroxyl groups. Complexing reactions lead to cross-linking of the molecules resulting in a three dimensional network which manifests itself in gel formation.

Guar industry in India

The development of guar industry in India has a bright future. If properly taken up it may save large amount of foreign exchange.

Already an improved method for the extraction of guar gum has been developed (R. R. Patel, *Indian Patents* 61005 and 61044, 1958), which is based on soaking the seed in certain solution to loosen the hull. National Research and Development Corporation of the Government of India has also made available a method for extraction of guar gum based on loosening of the hull by heating the seeds. This process also destroys the enzymes, which otherwise results in the degradation of the gum-sols and lowers its viscosity.

Indian Agricultural Research Institute, New Delhi, has developed high yielding variety of guar seed.

Currently the raw guar gum is exported to western countries. Derivatisation of the gum yields useful products, but due to the limited availability of alkene oxides, much attention has not been paid to making guar gum derivatives which can be used for specific industries within the country. Carboxymethyl derivatives are now being made for use as textile printing gums. An unusual application of guar gum is in making cross-linked gel filtration medium for the separation of macromolecules similar to dextran-gels (sephadex). Research is being carried out at various agricultural research stations in India to develop new and improved guar seeds.

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Genetic erosion

ALTHOUGH the rapid popularization and large scale cultivation of high yielding and widely adapted wheats and rices have saved a substantial proportion of humanity from the misery of nutritional sufferings, their devastating effects on crop genetic resources could not be realised even by serious geneticists and plant breeders until very recently. The rapid and extensive switch-over to the cultivation of high yielding and widely adapted varieties, have restricted the genetic variability in crops by way of displacement and disappearance of long adapted primitive land varieties of high diversity. Widespread introduction of intensive culture methods have contributed in their own way towards the erosion of genetic resources by minimizing or even removing the environmental differences and thereby reducing the number of habitats or habitat-diversity. For instance, even a little over two decades ago or so, ancient land races of wheat and barley were abundant in Turkey, Iran, Ethiopia and the neighbouring countries with maximum diversity, but now only traces of the former diversity can be found in this region. Short-statured, high yielding and fertilizer responsive Mexican wheats and a few of their promising derivatives are spreading as fast as their seeds are becoming available, the effect of which is the erosion of whatever remains of our genetic heritage built up since the dawn of agriculture. Another example of a species being threatened with extinction is the African rice, known as *Oryza glaberrima*. It originated in West Africa independently of the Asian rice, known as *Oryza sativa*. A survey conducted in 1936 on the plains of Banfora, upper Volta showed African rice to be the dominant rice grown. By 1967 it was found that the African rice comprised less than 10 per cent of rice grown in that area, the major rice being the Asian rice cultivars. Today the area under African rice is very much reduced all over west Africa and the complete gene pool faces extinction.

The state of genetic erosion in Indian wheats and rices is equally alarming. With a few high yielding varieties, now accounting for more than 55 per cent of the total wheat area, the once great diversity of wheat in India has all but disappeared. The remaining unselected indigenous wheats are now confined to hills in the North and North-East Himachal Pradesh, U. P. and Kashmir. By the end of the 5th Plan period (i.e., 1978-79) wheat area under high yielding dwarf varieties is likely to be increased upto 75 per cent and rice area under high yielding dwarf varieties is proposed to be increased to a level of more than 40 per cent. Although an excellent collection of Indian rice varieties exists at Central Rice Research Institute, Cuttack, Orissa, rice workers intimately connected with rice germ plasm resources feel that it represents only half of the total races (cultivars) found in India and a good deal of material still remains to be collected, particularly from North-East India, Orissa, North-East Deccan Plateau, Tamil Nadu, Kerala, Karnataka and Kashmir where indigenous types still persist.

The threat is not restricted to wheat and rice only, although in these crops the dynamics of erosion processes are greatly accelerated by the dramatic developments taking place. Displacement of natural gene pools began with the advent of modern agriculture decades ago. Now it threatens all crops and all areas wherever the primitive varieties still exist and intensive agricultural practices are followed.

The application of hybrid vigour mediated by male sterility is spreading rapidly to more agricultural and horticultural crops, superseding thereby the genetic diversity of primary and secondary centres. For instance, the introduction of hybrid maize into Europe wiped out the secondary gene centres of this crop in Italy and the Balkan peninsula. In 1931, hybrid maize accounted for less than 1 per cent of the maize acreage in U. S. A. But by 1944, more than 80 per cent of the maize area was under hybrids. In the corn belt the acceptance of hybrid maize was so complete that open pollinated local cultivars virtually disappeared.

In India, hybrid maize, hybrid sorghum and hybrid bajra, etc., have not been popularized as fast as dwarf wheats and rices. So, the valuable germ plasms of these crops in our country are not in imminent danger, although they should be systematically collected and preserved before it gets too late.

The expansion of agricultural crops is also threatening the important gene centres of forage species, weeds and wild relatives of other domesticated plants. Gene pools of many wild species which are directly used in forestry or as range and forage species are more immediately threatened. Foresters are acutely concerned at the loss of valuable genetic resources in various parts of the world, especially in tropics, through the felling of indigenous forest trees, deforestation for agricultural developments, replacements by exotics or destruction by fire or by the introduced parasites. Genetic diversity of fruit trees has greatly suffered from selections or introductions. Successful introduction for instance, of highly improved peaches have entirely replaced the local types in Turkey. Introduction of apples, pears and cherries have also been successful and have eliminated many local varieties. Many local cultivars of genetic value have disappeared and many others will disappear as old orchards are replaced by new ones.

The I.U.C.N. (International Union for the Conservation of Nature and Natural Resources) *Red Data Book* suggests that man has increased extinction rates at least four-fold, essentially through large reduction in the number of habitats, in population numbers within the habitats, and presumably through the loss of genetic variation. Otto Frankel of C.S.I.R.O., Australia, has warned that by 1985, most of the genetic resources in their ancient centres of diversity might well have disappeared. Thus the task for genetic conservationists is now to set priorities, based on the national and global importance of crop and the state of their existing diversity, for systematic collection of adequate germ plasm resources. This calls for a systematic and extensive collection of diverse genetic resources and the development of efficient and effective conservation strategies.

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Synthetic bi-vitamin —vitamin A$_E$

GENERALLY it is found that a particular vitamin is associated with a specific deficiency disease. Two different sets of deficiency diseases normally cannot be cured by any single vitamin. For example, vitamin *A* is essential for the maintenance of normal vision in man and animals; its deficiency may lead to various eye disorders and even blindness. Lack of vitamin *A* also causes diseases of the respiratory, intestinal and genito-urinary tracts. Moreover, defective tooth enamel and bone abnormalities may also result from inadequate vitamin *A* supply at critical stages of development. Similarly, vitamin *E* (anti-sterility vitamin) is essential for reproduction. In animals, and possibly in man also, the primary effect of vitamin *E* deficiency is nutritional muscular dystrophy (degeneration). Vitamin *E* has been found useful in cases of habitual abortion (miscarriage), muscular dystrophy, cardiac and vascular disorders, and during menopause in women.

If a patient shows symptoms of deficiency of both *A* and *E* vitamins, he cannot be completely cured by administering either of these vitamins alone. He has to be given both the vitamins. Two Japanese chemists, M. Morioka and S. Kitamura, have recently synthesized a new vitamin compound which acts simultaneously as vitamin *A* and *E*. They prepared it by treating vitamin *A* with 2, 3, 5,-trimethyl hydroquinone and oxidising the product. The dual activities of the new compound have been verified experimentally by clinical and biological trials (Japanese patent, No. 75, 149, 650: 1975).

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Molecular essence of mammalian maleness

ALL higher animals are found in two distinct sexes—male and female. The process by which individuals become either male or female is known as sex determination. The precise mechanism by which the sex of an individual is determined is still a biological riddle. But it is known that the sex of an individual is established as soon as the female egg is fertilized by the male sperm. It is now well documented that in most animals, including human beings, the difference between male and female is that the males possess an *X* and a *Y* chromosome whereas females contain two identical *X* chromosomes in their body cells. It is believed that the *Y* chromosome in man and other mammals is the male determiner. But the whole *Y* chromosome may not be essential for determining male sex. A large part of mammalian *Y* chromosome is supposed to be genetically inert. What exactly the *Y* chromosome contributes that turns the *XY* individuals into a male, is still a matter of dispute. For last several years, immunobiologists have been trying to trace the relationship between maleness and *Y* chromosome in animals, specially in mammals. Recently, a team of immunobiologists and geneticists has proposed a new hypothesis which may be considered as the molecular essence of mammalian maleness.

Drs. Stephen S. Wachtel, Gloria C. Koo and Edward A. Boyse of the Sloan Kettering Memorial Cancer Centre, N. Y. (U.S.A.) and Susumu Ohno of the City of Hope National Medical Centre, California (U.S.A.) have proposed the existence of a special type of antigen, which they call *H-Y* (histocompatibility-*Y*), antigen, on every single cell surface of males (*Nature*, vol. 257, No. 5523, 1975). They say during early embryonic development in males the *H-Y* antigen, produced by a gene or a set of genes present in the *Y* chromosome, influences cells of primitive and undifferentiated sex organs to become testes. In females, on the other hand, the absence of the *Y* chromosome, and thus the

H-Y antigen, allows the undifferentiated sex cells to become ovaries. Once the individual develops testis under the influence of *H-Y* antigen, the testes begin to release the male hormone testosterone which is responsible for the appearance of the other masculine features.

But testosterone alone cannot work unless the target cells of the resulting male individual are equipped with a special site for the hormone action, called 'testosterone receptor.' It is the product of a gene, present in *X* chromosome (the normal partner of the *Y*), which takes on the task of preparing the site on which the hormone can work. Dr. Ohno suggests that the product of the said gene activates all subsequent genes required for the expression of the masculine features, in response to circulating testosterone.

The role of *H-Y* antigen in sex-determination is further elucidated by immunological tests on some mouse strains. If the skin of a male mouse containing *H-Y* antigen is grafted on the body of a female of the same strain the graft is rejected at once. This experimental evidence has been extended by Dr. Boyse and his coworkers over a mutant mouse strain known as *Tmf*. Males of this strain phenotypically resemble females in all respects except that they possess a tiny and rudimentary testis. This abnormal condition results from the failure of target tissues to respond to testosterone, so that all masculine paraphernalia that are testosterone-dependent are absent in these males. When the skin of a *Tmf* male is grafted on the female of the same strain, the female rejects the graft. This indicates that though *Tmf* males resemble females in almost all respects, they possess the usual *H-Y* antigen like normal males. Genetical studies have revealed that, unlike normal males, the *X* chromosome of *Tmf* males lacks the usual testosterone receptor. It is for this reason that the masculine features of *Tmf* males remain unexpressed throughout their life.

The existence of *H-Y* antigen has also been documented in many other groups of animals, particularly in birds and amphibians. Exactly what role it plays in the process of sex determination in these non-mammalian creatures is still not properly known.

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Manganese in plants and animals

ALTHOUGH manganese was not identified as an element until 1774, some of its ores have been known from times of antiquity. Reference is found in ancient writings of the use of the mineral, pyrolusite (MnO_2) to bleach the green or yellow colour of glass.

In 1774 a Swedish chemist, C. W. Scheele realised that pyrolusite and its extracts contained a new element but he did not succeed in isolating it. This was achieved by J. G. Gahn in the same year. Although pyrolusite is non-magnetic it was classified as *lapis magnes* in early times because its external appearance was similar to the magnetic oxide of iron. The name of the metal was derived from the latin *magnes*, or magnet, the German equivalent is mangan and the French manganese.

Manganese is widely distributed in the combined state. It is the twelfth most abundant element and constitutes about 0.085% of the earth's crust. Of the heavy metals, only iron is more abundant.

Manganese is one of the trace elements essential for plants and animals. The cells of all living things contain minute concentration of manganese. The normal requirement in the human diet has been estimated at about 4 mg per day. Tea and coffee as well as nuts and cereals have high manganese content, but milk products and sea foods have low contents.

In some parts of the world, e.g., parts of USA where the soil is deficient in manganese, manganous sulphate or oxide is added to fertilisers. Small amounts of manganese compounds are also added to many animal and chicken feeds, and some vitamin-mineral formulations contain manganese glycerophosphate and manganese hypophosphite as nutrients.

An unknown manganese complex is involved in photosynthesis and the element is essential in the energy conversion unit of the plant. It is involved in the oxygen production step in photosynthesis.

Besides photosynthesis, manganese is known to activate other enzymatic processes. It is thought to be involved in oxidative phosphorylation, and in the activation of enzymes such as originase, enolase and peroxidases. It also promotes the synthesis of cholesterol. Some manganese metalloenzymes and manganese activated enzymes are known.

Manganese deficiency in higher plants causes mottled chlorosis (lack of chlorophyll) in which the leaves become yellow while the veins remain green. Although manganese is essential to man, in high concentration it becomes quite poisonous. Chronic manganese poisoning has chiefly been found in miners who work either in manganese mines or in ore-crushing mills. Manganese enters the body via lungs by inhalation of the dust **and** chronic manganese poisoning usually results after one to three years exposure. Some people seem to be more prone to attack than others. The first symptoms are of psychic nature and can take the form of fits of laughter or crying. Later, neurological changes occur and the patient suffers from trembling, rigidity and the general symptoms of Parkinson's disease. Chronic manganese poisoning is incurable once the symptoms have passed the early stages.

Today manganese poisoning is not an industrial problem because the enforcement of modern safety practices can easily prevent it.

Manganese salts taken into the body either by injection or orally are however not so dangerous since most of them are excreted.

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Prostaglandins in animal reproduction

"PRACTICAL control of breeding of beef and dairy cattle will be possible through the use of prostaglandins. When prostaglandins become commercially available for use in cattle, they will bring a dramatic increase in genetic improvement through expanded economical use of artificial insemination," says Dr. H.A. Hafs of Michigan University (*Jour. Vet-Medicine/Small Ani-Clinician*, 1976; 71: 846-848).

In the year 1935 Von Euler discovered a smooth muscle stimulating lipid in human seminal plasma, and named it as prostaglandin. Current research shows that prostaglandins are a new family of acidic lipids, derived from a parent 20-carbon carboxylic acids called "prostanoic-acid." The unsaturated fatty acids such as dihomolinolenic-acid, arachidonic acid, and all cis-eicosa 5, 8, 11, 14, 17 pertaenoic acid are shown to be converted enzymatically to prostaglandins, by the enzyme "prostaglandin-synthetase" which is associated with microsomal-membranes and requires an unidentified heat stable cofactor. The biochemical configurations of thirteen naturally occurring prostaglandins have now been determined. The various types and sub-types of prostaglandins are E-type (E_1, E_2, and E_3); F-type (F_1 alpha, F_2 alpha, and F_3 alpha); A-type (A_1 and A_2) and B-type (B_1 and B_2). Normal human seminal plasma contains the highest concentration of prostaglandins type E, F, A and B. Ram seminal plasma contains only E and F type. Prostaglandins, even though not present in the male accessory glands of many species, do occur in small amounts in other tissues. Prostaglandins type E_2 and F_2 alpha are the principal types detected in human tissues and body-fluids, other than the seminal plasma.

Prostaglandins have a wide variety of striking pharmacological properties both ***in vivo*** and ***in vitro***. Individual prostaglandins, in exceedingly small doses, may stimulate or relax uterus and fallopian tubes, stimulate intestinal smooth muscle, constrict the pupil, dilate peripheral and coronary arteries, constrict veins, constrict nasal and placental blood vessels, excite or inhibit central neurons and inhibit lipolysis, platelet aggregation and gastric secretion. They are released spontaneously from various tissues, and the amounts released are increased by nerve or neuro-hormone stimulation. Despite the recent advances in prostaglandin research, their primary site and mechanism of action, precise physiological function, relationship to certain disease states and essentiality for life are still not very clear. A recent interesting finding is that certain hormone secreting tumours such as medullary carcinoma of the thyroid and carcinoid tumours excrete excessive amounts of prostaglandin E_2 and F_2 alpha. It is likely that these prostaglandins are responsible for the gastrointestinal symptoms occurring in patients with these neoplasms. Current research suggests that prostaglandins may control certain hormonal actions at the local tissue level through their effects on the cyclic 3′–5′adenosine monophosphate synthesizing enzyme.

In a herd of cows, with normal oestrous cycles, prostaglandin offers a method of synchronizing oestrus in entire herd, without need for heat-detection by cattle-breeders. Studies were conducted on a group of normally cycling cows given injections of prostaglandin: the first injection during the two-thirds of the 21 day reproductive cycle, and the second 10 to 12 days later. The cows were artificially inseminated 80 hours after the second injection of prostaglandin, without making efforts to detect the signs of oestrus. Results showed that calving rates of prostaglandin treated cows were higher when compared to the calving rates of untreated inseminated cows. So in a large herd of cattle all the normally cycling cows can be brought into heat at about the same time for insemination. This will be of much use in she buffaloes, which are silent-heaters. Prostaglandin treatment gives an opportunity to greatly expand artificial-insemination, thereby improving cattle-productivity. But Dr. Hafs cautions that "prostaglandin is no substitute for good management." The drug will control breeding only in cycling cattle. It will not induce oestrus in malnourished or undersized heifers or suckling cows, until they recycle normally.

Prostaglandins also find an important place in equine-breeding. In normally cycling mares, prostaglandin F_2 alpha influences and helps to control the timing of oestrus. Mares can be bred during the induced oestrus.

Scientists believe that the animal's body produces a burst of prostaglandins 2 to 3 days before oestrus, to initiate the signs of heat and ovulation. The use of prostaglandins in animal breeding opens up new vistas for boosting meat and milk production through improved genetic strains of cattle.

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Acidophilus milk—a therapy for gastro-intestinal disorders

ACIDOPHILUS milks are sour milk products that have been allowed to ferment under conditions that favour the growth and development of a large number of *Lactobacillus acidophilus* organisms. Acidophilus milks differ from Indian *dahi* in that the milk used in the preparation and the type of micro-organisms involved are different. The final product differs from *dahi* in body, texture, consistency, flavour, chemical composition and in anti-bacterial activities.

Therapeutic properties

Besides their therapeutic properties acidophilus milks play an important role in nutrition. In the beginning of the 20th century considerable interest was evinced in the therapeutic value of fermented milk preparations, particularly acidophilus milks. They are known to control gastro-intestinal disorders such as diarrhoea, constipation, dyspepsia (indigestion), flatulence (gas/air in stomach), colitis and several other alimentary disorders in adults and children.

Products of mixed fermentation such as acidophilus yeast milk which is rich in alcohol and carbon dioxide excite the respiratory and central nervous system. This improves the process of oxidation and reduction in the organism and hence there is an increase in the oxygen flow to the lungs. In the Soviet Union, acidophilus yeast milk is widely used in treating tuberculosis.

Several articles on the therapeutic use of *L. acidophilus* have appeared in recent issues of scientific journals published both in the U.S.A. and Europe. In Europe, acidophilus milks are recognised by medical profession for the treatment of certain intestinal disorders such as constipation and colitis. Recent work at Oregon State University (U.S.A.) has shown that feeding of *L. acidophilus* concentrate to piglings not only controls infantile diarrhoea, but also suppresses the causative enteropathogenic *Escherichia coli* in the intestinal tract.

The recent emphasis on feeding lactobacilli is attributed to the side effects of antibiotics. Antibiotics alter the intestinal microflora, and intestinal discomforts are caused by flatulence and diarrhoea. Induction of *L. acidophilus* into the intestine accelerates return to normalcy in the intestinal microflora. A Rumanian strain of *L. acidophilus* is claimed to have been produced for treatment of gastro-intestinal disturbances in pigs and calves.

Some reports suggest that acidophilus milk therapy not only relieves conditions like uncomplicated gastro-intestinal disorders but also produces a feeling of general vigour and health. It has been reported that acidophilus milk products combined with chemotherapeutic preparations can also be effectively used for several diseases such as typhoid, para-typhoid, psoriosis, osteomyelitis, pneumonia, migraine and urological infection. Experiments have revealed that the body weight of a child, or an animal increases when fed with acidophilus milk preparations.

Characterization of *Lactobacillus acidophilus*

L. acidophilus was first isolated from faeces by E. More of Holland in 1900. It is now recognized as more or less regularly present in the normal intestinal tract of man and other warm-blooded animals. It also occurs in sour and aromatic foods, fermented milks, silage, and saliva. On microscopic examination *L. acidophilus* shows moderate to long bacilli, frequently in rigid chains or filaments. It is gram positive, nonsporulating rods. Below 15 °C it does not grow and the optimum temperature for the growth is 35 °C to 42 °C. *L. acidophilus* retains its viability through the digestive tract and implants itself in the lower intestine. In fact, the ability to survive in the intestinal tract is one of the chief identifying characteristics of *L. acidophilus*.

The therapeutic action of acidophilus milk is believed to be due in part to the bacteria (*L. acidophilus*) that reach the lower intestinal tract and not entirely to the acidity of the milk. *L. acidophilus* has been described as a "living antibiotic" and the antibiotic which it produces has been tentatively called acidophiline, lactocidin and acidoline by different scientists. These antibacterial substances inhibit the growth of a variety of microorganisms like *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typheae*, *Salmonella dycentreae*, *Micrococcus flavus* and other pathogenic and non-pathogenic bacteria. No harmful effect of *L. acidophilus* has been reported so far.

Preparation of acidophilus milks

L. acidophilus-based fermented products differ in the type of starter culture and milk used for their preparation. Acidophilus sour milk, as the name indicates, is a sour milk beverage made out of standardized milk, acidifying it by means of pure culture of acidophilus rods (*L. acidophilus*). Milk culture of *L. acidophilus* has the therapeutic value described earlier but does not possess the buttery, acetaldehyde flavour of the regular fermented milk products such as *dahi* and yoghurt.

It has been reported by many workers that *L. acidophilus* does not multiply rapidly in milk and is easily outgrown by contaminating bacteria, like micrococci. Hence the milk must be sterilized or nearly so, before inoculation in order to remove the possibility of contamination.

The procedure for the preparation of acidophilus sour milk has been standardized by the authors at Dairy Bacteriology Division of National Dairy Research Institute, Karnal (Haryana). The milk used for the preparation of acidophilus sour milk is standardized to 3.55% fat and 8.5% SNF content. For this preparation standardized milk is sterilized and is cooled to 40 °C. The milk is inoculated with 24 hour old pure starter culture of *L. acidophilus* at the rate of 3% to 5% and filled into 200 ml glass or plastic containers and incubated at about 39°C for 8-12 hrs. The product is then cold-stored (at 5°C-8°C) till it is consumed.

The product so obtained is sour with 1%-1.2% lactic acid (pH 3.7-4.0). The product should contain more than 2000-3000 million viable *L. acidophilus* organisms/ml which possess satisfactory antibiotic effect against *E. coli* as well as other pathogenic and non-pathogenic undesirable bacteria of the intestinal tract. The viability of the organism is of primary importance in the use of the acidophilus milk. The acidophilus sour milk can be preserved upto a week below 5°C.

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Bacterial fimbriae

SINCE the Dutch scientist Antonie van Leeuwenhoek first observed the bacterial cells in 1676, interests in the morphology of these tiny creatures have grown fast. They shared a large proportion of studies in the rapidly expanding areas of microbiology. With advancement in microscopy finer details of the internal cellular structures were revealed. Simultaneously different external structures or cellular appendages also came to light. Use of electron microscope helped much in this respect and structures hitherto unknown were revealed.

A new type of bacterial cellular appendages which are fine hair-like structures projecting from the surface of the cell and different from already known filamentous structures, flagella, were discovered independently by Anderson and Houwink in 1949. These structures have been subsequently termed variously as 'bristles', 'filaments', 'fimbriae' or 'pili'. But the terms fimbriae and pili have gained wide acceptance. Some authors have subdivided these structures into two groups: those which are involved in chromosomal transfer during conjugation have been termed as 'sex pili' and the others as 'common pili'. Still others have preferred to use the term fimbriae, specifically for these common pili.

At the present state of knowledge these structures seem to be restricted mainly to the gram-negative bacteria. Among the gram-positive group they have so far been observed only in *Corynebacterium renale*. Fimbriae or pili may be present at one end or both the ends of the cell or may be distributed throughout the cell surface. A single cell may carry from 1 to about 1000 of these appendages. These are generally 30Å to 250Å in width and may vary in length from 0.2 μ to 5 μ or more. (1 μ or micron $=10^{-3}$ millimetre-1000 m μ or millimicron=10,000 Å or Angstrom unit). They are more or less straight, tubular structures, which consist of a hollow core and a cylinder of repeating subunits. Chemically they are composed almost exclusively of protein which has been termed fimbrilin or pilin having a molecular weight of approximately 17,000.

Fimbriae or pili are similar to flagella in some respects. Flagella originate from the cytoplasm and penetrate through the cell wall. Similarly, these nonflagellar appendages are also regarded as cytoplasmic extrusions through the cell wall. Regarding distribution also, both flagella and these nonflagellar appendages show some similarities, they may originate either from the cellular poles or from random positions throughout the cell surface. The discovery of a basal body in the cytoplasm of *Proteus mirabilis* from which the fimbriae arise also points to a further degree of similarity with the flagella (at least in *P. mirabilis*). But the fimbriae or pili differ from flagella in being much thinner. Functionally also these nonflagellar apendages differ distinctly from the motility appendages or flagella.

Functions The common pili or fimbriae function mainly as organs of adhesion. With the help of fimbriae, the bacteria can adhere firmly to solid surfaces of various kinds including cells of animals and plants. It has been found that the nonfimbriate cells of the same type of bacteria do not adhere when they come in contact with such surfaces. This adhesive property of fimbriae may be of some value to the bacteria as it helps in holding the cells in nutritionally favourable microenvironments. If a drop of a concentrated suspension of fimbriate bacteria is mixed with a suspension of red blood cells the latter are agglutinated, that is, they are brought together into clumps. This haemagglutination reaction is caused by the adhesion of the fimbriate bacteria to the red blood cells. The adhesive property of fimbriae is also manifested through the formation of a surface film of growth on an undisturbed, static liquid medium. The formation of this film on pellicle has an obvious physiological function. It gives the fimbriate cells a better chance to get free supply of oxygen from the atmosphere.

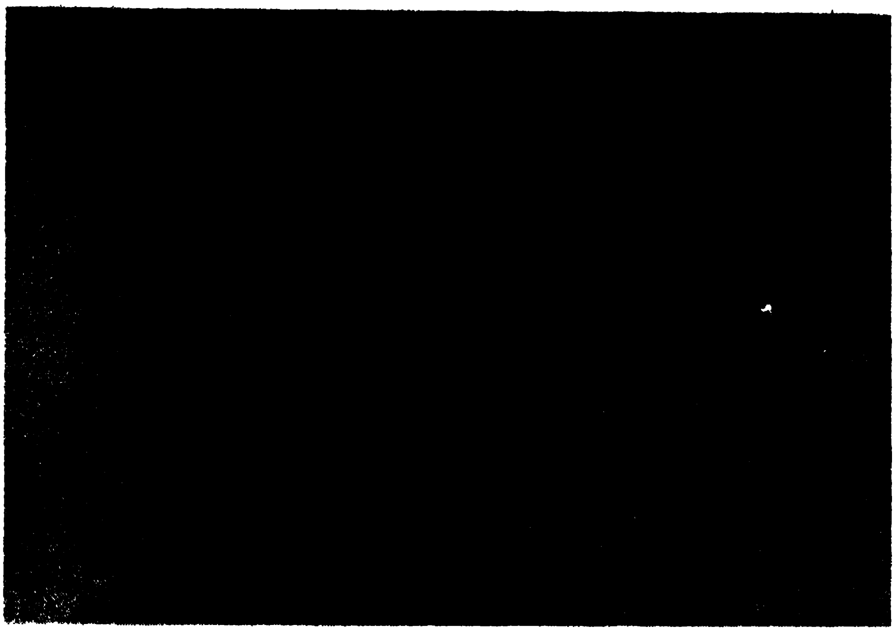

Fig. 1. **A strain of *E. coli* K12 JE 1031 cell having F. pili with male-specific MS2 phage attached, common pili and flagella (reproduced with permission from *Progress in Biophysics and Molecular Biology*, 1975, Vol. 30, p. 36)**

Sex pili and their function. The formation of sex pili is determined by a type of plasmids (extrachromosomal DNA elements), the "sex factors". The term sex factor is broadly used here to include all transmissible plasmids, which are capable of promoting chromosomal or DNA transfer. The sex pili are exclusively found on the surfaces of male strains of bacteria. It has now been established that bacteria can be infected by bacteriophages (viruses) in two different ways: firstly by adsorption on the cell wall, and secondly by attachment to the side or tip of the sex pili. Hence, the second type of bacteriophage infection is confined only to the male strains of bacteria which carry the sex pili.

There is now little doubt that sex pili are essential for the process of conjugation by which genetic material is transferred from the donor (male) bacterium to the recipient one. But how these structures are involved in the mechanism of conjugation is still not completely understood. Two different models have been proposed to explain the role of sex pili in the phenomenon of conjugation. The "pilus conduction" model of Brinton suggests that the sex pilus may be a tube with an axial whole through which DNA is transported. The second model proposed by Marvin and Hohn (1969) and Curtiss (1969) is known as the "retraction model" These authors suggest that once the tip of the pili comes in contact with the surface of the recipient cell the pilus retracts thus bringing the two cells closer. DNA transfer then occurs by some unknown mechanism. It is now known that sex pili can elongate or retract continuously, various factors affecting the phenomena. But whether this retraction mechanism plays any role in conjugation is not known.

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Sea snakes and their venoms

SNAKES of the family Hydrophiidae are exclusively adapted to marine life. All of them are venomous and are more numerous than terrestrial venomous snakes. They are found in tropical and subtropical coastal regions of Indian and Pacific Oceans. Their venoms are known to contain potent neurotoxins which are among the strongest natural toxins found in the world.

Non-poisonous water snakes are often mistaken for sea snakes. In their native habitat, sea snakes are graceful and rapid swimmers. They frequently get entangled in fishing nets and are caught alongwith fishes. Fishermen carefully throw them back in the sea. Eventhough sea snakes are sluggish and bite only under provocation, their bites are quite common and deaths are not unusual among fishermen. Sea snake bites constitute an occupational hazard among fishing folk.

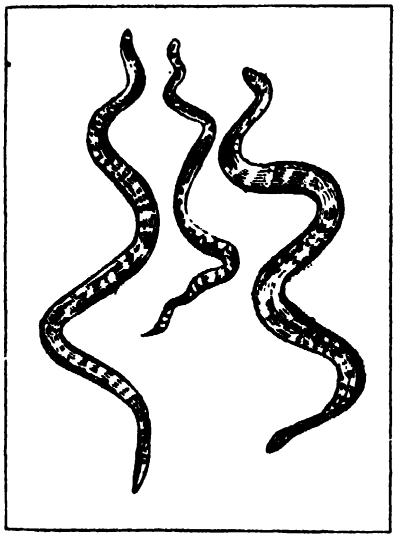

Fig. 1. *Enbydrina schistasa* (common sea snake)

Rudderlike and distinctly flattened tail, and uniformly transverse dark bands on their body are the characteristics of sae snakes. Ventral scales are very much reduced while body scales are less imbricated. The head and eyes are small. Nostrils are provided with small internal valve to prevent entry of water.

Family hydrophiidae (sea snakes) is divided according to the habitat into two subfamilies, Hydrophinaie and Laticaudinae. Hydrophiinae snakes are purely aquatic and their nostrils are situated on the upper part of the snout, while Laticaudinae snakes are amphibious and their nostrils are placed laterally. Snakes of the family Hydrophiinae are distributed along the western coast of India and Persian Gulf, while Laticaudinae snakes are distributed along the eastern coast of India, Bay of Bangal and Japan's coastal area.

The most common species along Indian coast are:

Hydrophiinae: *Enhydrina schistosa, Hydrophis cyanocinctus, H. nigrocinctus, M. caerulescens, H. cantoris, H. fasciatus, H. gracilis, H. lapemoids, H. mammilaries, H. obscurus, H. ornatus, H. spiralis, Astrotia stokesii, Lapemis curtus, Microcephalophis cantoris, M. gracilis, Praescutata viperina* and *Pelamis platurus.*

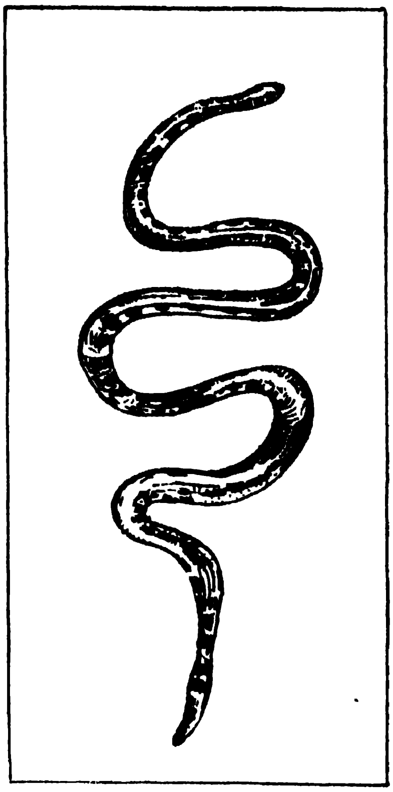

Fig. 2. *Hydrophis cyanocintus*

Laticaudinae: *Laticauda colubrina* and *Laticauda laticaudata.*

Fishermen admit that sea snakes never attack human beings without provocation. They are not aggressive. Rarity of sea snake bites may be due to their sluggish behaviour. Their mouth too is small and fangs are situated deep inside, as compared to land snakes.

Reported sea snake bite cases are few and far between. On Indian coast, there are only two such historical records. On Madras river mouth, in 1815, M'kenzie noted an "epidemic" of sea snake bites and described some 31 such incidences. H. W. Peal of the Indian Museum, Calcutta reported in 1903 that he had been told about 3 to 4 fishermen being bitten each year in a fish-

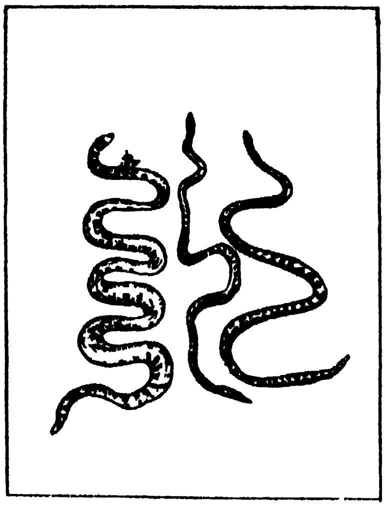

Fig. 3. *Hydrophis* species

ing village on Orissa coast with a mortality rate of 25%. Since then no report of sea snake bites on Indian coast has been recorded in the literature. Fishermen of Bombay and Ratnagiri sea coast say that sea snake poisoning cases occur even today.

Sea snake bite is often painless and therefore its victims often go unnoticed. Moreover, many bites are defensive and seldom eject venom. In spite of this, there are strong superstitions in the fishing folk regarding sea snake bites.

Samples : 1. Talk about sea snake bites offends sea snakes and it may change their timidity to aggressiveness, 2. If a victim talks about the bite, he may be bitten again, and 3. If a pregnant woman hears of sea snake bite, the victim may die.

Sea snake venom is a complex mixture of biologically active components such as enzymes and toxins secreted through a venom gland which is a modified salivary gland.

From his personal observations of 115 sea snake bite patients from Malayan coast, H. A. Reid of the School of Tropical Medicine, Liverpool, England, concluded that 'myoglobinuria' (red coloured urine) is the main clinical symptom observed in sea snake poisoning. It starts after 2 to 3 hours of the bite. Hyperkalamia (excessive potassium in the blood) is concomitantly observed. The possible causes of death are therefore, respiratory failure, hyperkalamia, or acute renal failure. In experimental animals, death is due to neuromuscular paralysis followed by respiratory arrest.

Land snake antivenin is ineffective against sea snake venom. A refined therapeutic sea snake antivenin is manufactered by Commonwealth Serum Laboratories, Melbourne, Australia. It is the only specific therapy against sea snake bite. It is fortunate that in four of five cases of sea snake bites, little or no venom is injected and the victims do not require antivenin. Artificial respiration can be used as a supportive treatment but the specific antivenin is the usual remedy in severe cases. Haemodialysis is an alternative if specific antivenin is not available.

Though India has a large sea coast, very limited attention has been given to the studies of sea snake venoms. On Indian coast, except some preliminary studies by Capt. L. Rogers of the School of Tropical Medicine, Calcutta in 1903 to 1904, no significant work has been done. Rogers in his studies reported that sea snake venom is primarily neurotoxic in experimental animals without significant haemolytic action. It is 10 times more toxic in fishes than the cobra venom.

Further investigation on these venoms may lead to useful, pharmacologically active new moieties. Some specific enzymes of these venoms may prove useful in basic studies on cellular metabolism and pharmacological mechanisms and could ultimately lead to valuable discoveries.

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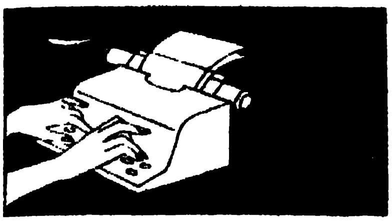

NEWS & NOTES

Dr. Ramachandran is new DGSIR

DR. A. Ramachandran, Secretary to the Government of India in the Department of Science and Technology, took over the additional charge of the Director-General, Council of Scientific & Industrial Research, on July 28, 1977.

At a meeting with CSIR scientists Dr. Ramachandran said, "Science and technology in India has to play a very important role for the social and economic betterment of the people, especially of the rural people. Technology should not only answer the needs of the industry, but should also address itself to the urges and aspirations of the rural people and the weaker sections. This is a great challenge before the Indian scientists."

Dr. Ramachandran has held responsible positions in the fields of research and education. He was Director of the Indian Institute of Technology, Madras (1967-73) Head of the Deptt. of Mechanical Engineering, Indian Institute of Science, Bangalore (1957-67) and also Head of the Deptt. of Industrial Management (1965-67). He was Assistant Professor of Mechanical Engineering (1950-57) at the Indian Institute of Science, Bangalore.

His distinguished career in the fields of Technology and Enginereing has earned him national and international recognitions. He is Fellow of the Institution of Mechanical Engineering (London) Fellow of Institution of Engineers (India); Fellow of American Society of Mechanical Engineers (USA) and President of Solar Energy Society of India (1977-78).

Similarly, he has won several international awards and honours for his contributions to technology. He was awarded an Honorary degree of Doctor of Ingenieur conferred by Stuttgart University, Federal Republic of Germany. He is Fellow of the Indian National Science Academy, New Delhi and Fellow of the National Academy of Sciences, Bangalore.

Dr. Ramachandran

Quark detected ?

A Stanford University physicist has recently reported the first evidence hinting at the presence of a quark, the hypothetical tiniest building block of everything. Quarks have existed in theory for 13 years, but till now physicists have been unable to isolate one and some scientists have come to believe they never would be found.

The development was reported by Dr. W.M. Fairbank at the annual meeting of the American Physical Society. He emphasized that the finding was tentative and needed to be confirmed by further research. Fairbank said, he detected in complex laboratory experiments what appeared to be an electric charge of one third of the charge of an electron. Such a fractional charge had never before been observed and is considered to be an evidence of a quark. The smallest known charges are those of the electron and proton. There are two cases where we have been unable to account for one third of a charge by any spurious forces except by postulating a fractional charge. A charge of one-third of an electron was predicted by Nobel laureate Murray Gellmann when he theorized the existence of quarks in 1964.

The quark is the central concept in today's world of elementary particle physics. It has been used to explain some of the peculiarities that have turned up in particle research. According to theory, all elementary particles are formed from combinations of quarks. If Fairbank's work is confirmed and the existence of quark is proved, it would rank as a major advancement in the efforts of scientists to understand the fundamental constituents of matter. Fairbank used extremely low temperature laboratory techniques to measure the electrical charge. Whatever may be the ultimate outcome, the quark theory will hold the attention of physicists for some time to come.

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An Interview

Dr. P.C. Jain

"FOR making research relevant to industry and society, groups of scientists should be entrusted with time bound projects in their fields. Such projects should be supported with significant incentives," says Prof. Padam Chand Jain, the 1975 Bhatnagar Award winner in mathematical sciences. What he says is not new. All the same, it is an idealistic and theoretical statement as one expects from a mathematician. The catch in the statement is 'time bound' projects and 'significant' incentives. Both, however, need elaboration. Some science planner should look for an equation between these two crucial parameters: scientists working for 'significant' incentives and the time binding on them to finish a particular project. If one really derives such an equation to the satisfaction of the entire scientific community in the country, it would certainly be a panacea for all the ills present in our industry and society. Prof. Jain is only idealistic, he is not wrong.

Dr. P. C. Jain

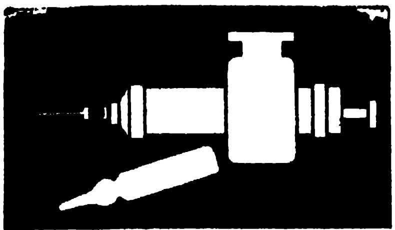
Presently, Prof. Jain is a Senior Professor at I.I.T., Bombay. It is his researches on "new Algorithms" that fetched him the country's top science research award. These algorithms could be used in solving non-linear mathematical models which arise in scientific and engineering problems.

Everyone knows that the experimental costs involved in designing machines, engineering structures, etc., are heavy. To save expenditure some preliminary analysis of the problem is thus made using certain analytical or approximate methods. The first step is to formulate a mathematical model of the physical/technological problem. Generally, such models turn out to be non-linear and complicated. So to get the solution one very often simplifies them to such an extent that they have limited relevance to the actual situation. Today, however, with the advent of high-speed digital computers, it has become possible to derive solutions of problems without drastically simplifying the assumptions. Prof. Jain's algorithms help in solving non-linear problems over domains with regular or irregular boundaries. Already, his techniques have enabled us in knowing more about fluid dynamics and its applications. They also hold considerable promise in solving still more difficult non-linear problems in fields such as environmental control, monsoon dynamics, numerical forecasting, pharmakinetics, biomechanics and MHD power generation.

A product of Delhi University, Prof. Jain had a brilliant career throughout. Besides being merit scholar he has held second and first positions at B.A.(Hons) and M.A. degree examinations respectively. Inspired by Prof. D. S. Kothari he took to research career. Regarding I.I.Ts., he says "the facilities here are comparable to those available in American universities".

Anything to say regarding our publications? According to Prof. Jain there is a dearth of mid-level journals devoted only to reviews. Also, he feels, "National Book Trust or University Grants Commission should organise a programme to publish lecture notes delivered by a team of experts on certain topics. The lectures may be organised at instructional level."

DILIP M. SALWI



MEDICAL NOTES

Chemistry of bad breath

ACCORDING to Baltasar Graciany Morales—a famous Spanish Jesuit prose writer (1601-1658), "reputation is the life of the mind, as breath is the life of the body." Bad breath is a curse. If a person's breath turns bad (sour), he finds himself isolated from society's contact. Nobody likes him to sit closer.

Medically, bad breath is called halitosis or *fetor exore*. Though the source of mouth odour is known to be the gingival debris (residual food matter in gums), not much is known about the nature or composition of unpleasant breath. Dr. Takeki Kaizu of Tokyo Dental College, Tokyo (Japan) has now successfully carried out chemical analysis of bad breath by means of gas chromatography (*Nippon Shika Ishikai Zasshi*, **29**, 228-235, 1976). Dr. Kaizu's analytical results have revealed the presence of hydrogen sulphide (H_2S), methyl mercaptan (CH_3 SH), and dimethyl sulphide (H_3C-S-CH_3)—chemicals that cause bad odour in the mouth and breath. A direct correlation between the intensity of bad odour and the concentration of these chemicals in breath has also been established. Ordinarily, H_2S smells like rotten eggs. Methyl mercaptan is known to be an intestinal gas arising from decomposition of proteins. It possesses a highly unpleasant odour. Dimethyl sulphide also has offensive odour. All the three chemicals are highly poisonous.

Dr. Kaizu has also described a compound 1-(2-hydroxyethyl)-2-methyl-5-nitroimidazole which when taken (100 mg) twice a day for only 2 or 3 days markedly decreases the concentrations of H_2S, methyl mercaptan, and dimethyl sulphide in the breath.

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Multiple sclerosis

MULTIPLE sclerosis (MS) is a disease affecting the central nervous system, which includes the brain and spinal cord. Unlike many chronic neurological disorders, MS patients have a life-span which approaches that of the normal population. It is a disease of unknown cause. However, there is some evidence that this may be related to a viral infection acquired early in life. There is no specific treatment as yet for MS, although some physicians have achieved success using cortisone or cortisone-like drugs.

The symptoms of this disease are variable and generally affect patients in the 20-40 age group. Loss of vision in one eye lasting for weeks, with return of normal vision is a common symptom. Disturbances in balance and extremities occur frequently, but most patients who have intermittent numbness and tingling may have other causes for such symptoms rather than MS. MS patients may have 'exacerbations' and 'remissions' of their disease. Exacerbation refers to an acute increase in signs and symptoms lasting a variable period of time. A remission indicates a steady state of neurological disorder.

There is no single diagnostic laboratory test for MS, and clinical diagnosis is mainly based upon the patient's signs and symptoms. Examination of the spinal fluid in a majority of MS patients, may show an elevation of one fraction of the spinal fluid protein. Research is under way to develop a blood-test which may be helpful in the diagnosis of MS, but this test is not yet available for clinical use. There are a large number of unknown factors regarding MS in terms of its cause and treatment, and even diagnosis. Despite this the majority of MS patients can continue their usual employment with only mild to moderate disability. In many cases the fear of having the diagnosis of MS is more disabling than the disease itself.

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U.S.A.

Of psychiatric disorders

THE exact causes of psychiatric disorders are a long standing problem before psychiatrists. A question often asked in this connection is : Are the observed biological and psychological abnormalities in psychiatric patients themselves of etiological importance; or, are such changes the result of the disorder ? For studying psychiatric disorders there is an approach called "high risk". The high risk studies focus on apparently normal individuals who have never been victims of mental disorder, but are supposed to be vulnerable to psychiatric disorders. The "high risk" study employs familial models—that is, offsprings and relatives of a clearly defined patient are selected for the purpose.

In a recent study, M.S. Buchsbaum and others of the National Institute of Mental Health, Bathesda, Maryland, (*Science*, **194**, Pp. 339-340) used the activity of an enzyme, monoamine oxidase (MAO), in blood platelets as a biochemical indicator of a population at a hight risk to psychiatric disorders. MAO was used as an indicator because previous studies had revealed low levels of MAO in patients with chronic schizophrenia or some depressive disorders; and because MAO is genetically controlled and is associated with some "personality test differences" in normal males. But there are some other points concerning MAO which too merit attention. For example, not all psychiatric patients have a low MAO activity, and that some normal individuals too have a low activity. Researchers, however, wonder if normal individuals with low MAO are really so or they have some hidden disorders or vulnerability which is protected through some "ameliorative characteristics" in their neurophysiology or environment. Or, do low MAO subjects lack some additional detrimental factors which along with low MAO increase the risk for psychological problems ?

The group at National Institute of Mental Health, Bathesda, studied 203 men and 172 women volunteers of age 18 to 38 years. Blood samples were taken from them and studied for MAO activity in platelets. Out of those found with low and high MAO activity, some were selected for a second test; persons with mean, low and high activity were selected for further tests. The final tests involved an interview on personal and family history and some psychological tests.

The study revealed interesting results. The low MAO subjects reported more frequent psychiatric or psychological counselling and more problems with the law. The low MAO families had eight times more incidence of suicide or suicide attempts than high MAO subjects. The study suggests that reduced MAO levels—as reported previously in patients with disorders and chronic schizophrenia—may predict an individual's vulnerability to psychological disorders.

ZAKA IMAM

New cures for peptic ulcer

PEPTIC ulcer is an acute or chronic condition of certain areas of the alimentary tract exposed to the action of gastric juice. It may affect the lower portion of oesophagus, first part of duodenum, lesser curvature of stomach and Meckel's diverticulum (an abnormal extension from the intestine to the umbilicus, which is said to contain acid secreting cells).

The cause of peptic ulcer is still not fully established. But various factors are attributed. Among them are excessive secretion of gastric juice, a decreased resistence of the mucosa to acid, reflux of bile into the stomach due to an abnormal pyloric sphincter, faulty blood supply to the stomach, undue stress etc. It is not uncommon to find a strong family history, which emphasises the fact that heredity also might play an important role. There is also an association between duodenal ulcer and blood group 'O' (See also: S. K. Basu, *S.R.*, **12**, 6, 1975, and J. Battacharya, *S.R.*, **13**, 2, 1976).

The most common method of diagnosis of peptic ulcer is by using barium meal radiography. But it is not very accurate (*Jour. Royal Coll. Phys.*, **10**, 1976, pp. 177-182). Direct visualisation of ulcer with the help of fibreoptic endoscopes is much better. Normally both methods are used in combination.

Treatment

There are three objectives in the management of peptic ulcer; the alleviation of symptoms, ulcer heal-

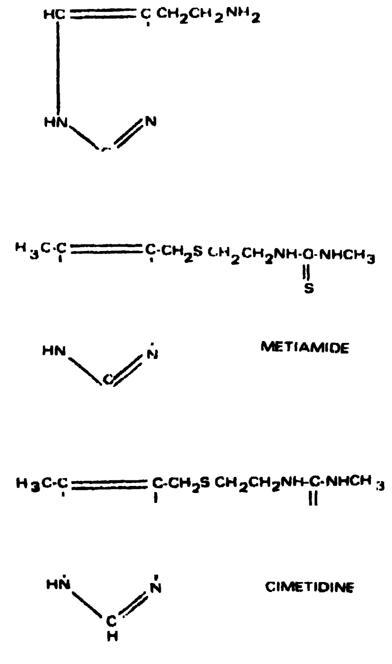

Fig.1.

ing and the prevention of recurrence. While it is now possible to fulfil the first two objectives the third, viz., the recurrence of ulcer, still poses a clinical problem.

The single most effective natural measure for the relief of ulcer pain and the promotion of healing is bed rest. Diet restriction does not seem to play a significant role though restriction may cause vitamin deficiencies in the long run. Staying away from smoking tobacco often proves beneficial. There is good evidence to show that this accelerates the healing of peptic ulcers.

Now come to drugs. Alkalis are required in massive quantities to bring up the pH of stomach, say 60 g of sodium bicarbonate a day, which is not practical. Lesser quantities alter gastric acidity for no longer than 10 minutes. In this respect, antacids come to our rescue by efficiently altering the gastric acidity and relieving pain. Most of the antacids contain an aluminium salt (usually hydroxide) to annul the acidity and a magnesium salt to counteract the constipating property of aluminium salt. Some may contain, in addition, either methyl polysiloxane or Simethicone to relieve flatulence. But antacids are not effective in promoting healing.

Drugs which inhibit the action of vagus nerve reduce gastric secretion. But no selective action of these drugs is observed on the stomach. They tend to cause dryness of mouth, urine retention and blurring of vision. Moreover, there is little evidence of healing or prevention of relapses by these groups of drugs. Another drug, carbenoxolone sodium, gives some benefits by promoting healing, probably by changing the nature and volume of mucus secreted and by prolongation of the life of the mucus producing cells (*Med. Dig.*, **22**, 1, 1977, p. 23).

New hopes have been raised with the arrival of the new drug—cimetidine. It is known that histamine, apart from producing a number of allergy-like effects, also stimulates gastric secretion. So an antihistamine should annul these effects. Indeed a number of antihistamines have been found to antagonise most of the effects of histamine—except the last one. They failed to influence gastric secretion.

In 1966, it was suggested that there might be two receptor sites for histamine. While histamine was able to bind to all types of histamine receptors, the antihistamines could only bind to one type of receptor—which was named as H_1 receptor. Efforts were made to synthesize a drug which would act on the histamine receptor sites in the stomach—called H_2 receptor sites.

The first successful drug to be synthesised was burimamide. But it had a low potency and was relatively ineffective when taken by mouth (*Med. Dig.*, **22**, 1,1977, p. 17). The next successful compound was metimide (Fig. 1) which proved effective on oral administration. In a clinical trial, a single tablet strikingly reduced acid secretion in patients at night (*Lancet*, **1**, 1974, p. 693). The drug was found to markedly reduce nocturnal and day-time pain and antacid consumption (*Brit. Med. Journ.*, **2**, 1975, p. 307). In another case (*Lancet*, **2**, 1975, p. 779) healing of the ulcer was significantly increased in those patients receiving metiamide (67%) as compared with the placebo group (25%). In some cases, reversible bone marrow depression was observed in patients using metiamide, and doubts were raised about its long-terms safety.

The thiourea group in metiamide was thought to cause the side-effect, so it was replaced by a cyanoguanidine group and thus cimetidine emerged.

Studies on animals showed definite toxicological differences between cimitidine and its predecessors (*Journ. Inter. Med. Res.*, **3**, 1975, p. 86); S. J. Haggie *et al* (*Lancet*, 8th May, 1976, p 983) report that 17 out of 19 patients with acute duodenal ulcer were healed after six weeks treatment with cimetidine (1.6 g/day). Perhaps the most impressive report came from two Swedish investigators, G. Bodemar and A. Walan (*Lancet*, **2**, 1976, p. 161). They found that 67% of the patients were cured of duodenal ulcer in three weeks time. At the end of six weeks, the cure rate was 90%. Side effects have not proved a problem. A few, however, have experienced pain in the breast and development of female-like breasts in male (gynecomastia) (*New. Eng. Journ. Med.*, **295**, 1976, p. 841). The effectiveness of cimetidine in preventing relapses is yet to be studied.

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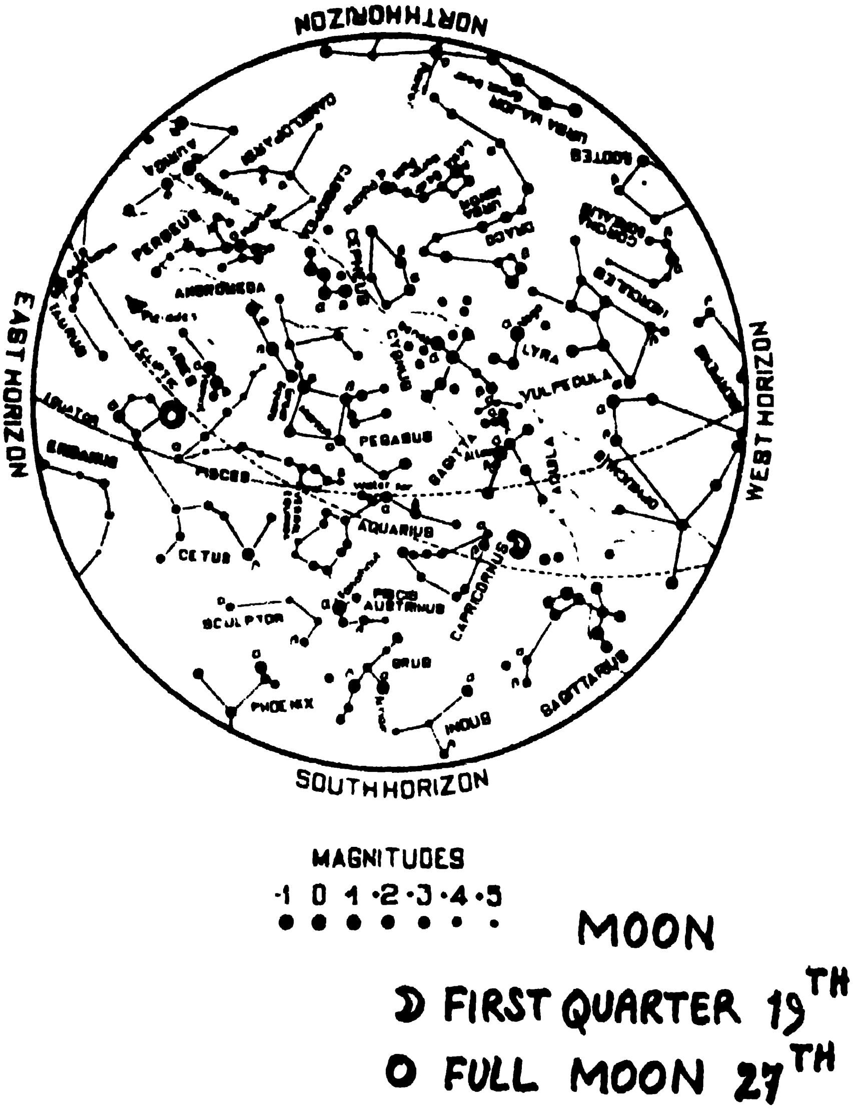
Planets and their positions

OCTOBER 1977



The moon

NEW moon occurs on 13th at 2-01 a.m. and full moon occurs on 27th at 5-05 a.m. I. S. T. The moon passes about five degrees south of Jupiter in the early hours of 5th, six degrees south of Mars on 6th, about five degrees south of Saturn on 9th and three and a half degrees south of Venus on 11th. The lunar crescent becomes first visible after the new moon day in the evening of 14th. The moon is at apogee or farthest from the earth on 3rd and again on 31st and at perigee or nearest to it on 15th.

There will be a total eclipse of the sun on the 13th but it will not be visible in India.

The planets

Mercury (Budha), a morning star, rises about an hour before sunrise during the first quarter of the month. Thereafter it is too near the sun to be visible. It will be in superior conjunction on 19th. It moves from Virgo (*Kanya*) to Libra (*Tula*). Its visual magnitude is about —1.1.

Venus (Sukra), visible in the morning sky, rises about one and a half hours before sunrise during the month. It moves from Leo (*Simha*) to Virgo (*Kanya*). Its visual magnitude is about —3.4.

Mars (Mangala), a morning star, rises about half an hour before local midnight during the second half. It will be in quadrature with the sun on 21st. It passes about six degrees south of the star Pollux (*Punarvasu*) in the evening of 13th. It moves from Gemini (*Mithuna*) to Cancer (*Karkata*). Its visual magnitude is about +0.7.

Jupiter (Brihaspati), visible in the morning sky, rises about two and a half hours before local midnight during the month. It becomes retrograde on 24th. It is in Gemini (*Mithuna*). Its visual magnitude is about —2.0.

Saturn (Sani), a morning star, rises about two hours after local midnight during the first half of the month and about one hour after it during the second half. It is in Leo (*Simha*). Its visual magnitude is about +0.8.

(*Source*:— Nautical Almanac Unit of the Meteorological Office, P–546, Block 'N' (1st floor), New Alipore Calcutta-700053)

SCIENCE FOR THE YOUNG

Biological clock

IN the universe, all phenomena are relative and cyclic. The environmental rhythm of recurring alteration of illumination and darkness is the earth's natural photoperiod, and the same has played a vital role in biological history of all living organisms, be they plants or animals. For example, in ancient times it was believed that periodic biological behaviour was nothing more than a direct response to some periodicity in the physical environment such as the day-night cycle, temperature, feeding, etc. Plants as well as animals have evolved the ability to utilize the daily cycles and seasonal variations of day-lengths as sources of environmental cues.

The rhythm of 24-hour rotation of the earth which includes both the periods of light and darkness is called the "circadian". This word is derived from Latin *circa* (about) and *dies* (day) and was first coined by Franz Halberg of the University of Minneosta, U.S.A. Indeed, as early as 1729, de Marian, the mathematician and astronomer, was fascinated by the daily periodic behaviour in the movement of leaves. Charles Darwin of England later noted similar phenomena and discussed them in his book *The Power of Movement in Plants*. This suggests that photoperiod is a dominant regulator of biological rhythms in plants as well as animals. However, this is far from the truth. Indeed, de Marian himself had observed some two centuries ago that when certain plants were grown in total darkness, their leaves bent daily, as if towards the sun. Similarly, when blind or normal rodents were subjected to continuous light, their adrenal hormone secretions and other rhythms were not affected.

These examples point out that there is an inbuilt regulator which regulates biological rhythms. They precisely demonstrate that many plants and animals, including man, have daily rhythms of behaviour which seem to be endogenous in origin (internally regulated). This hypothetical built-in or endogenous device which regulates the various chronobiological phenomena has been given the name of 'Biological clock'. It is believed that organisms can keep their behavioural, biological and physiological rhythms going in three ways. Firstly, they can respond directly to changes in the environment, such as photoperiod, temperature, availability of food and mate, etc. Secondly, they can be endogenously programmed to respond in a specific way at a specific time irrespective of the environmental cues. Thirdly, both responses can be combined. It is now well established that the daily rhythmic behaviour of many organisms is under the control of an internal circadian clock and that external factors such as the daily variation in the intensity of day-light influence and modify it to a very limited extent. It is, however, rare that the frequencies of these rhythms average precisely 24 hours. Their timing changes predictably each day in relation to clock time, that is, biological rhythms keep their own time not exactly corresponding to the day's length.

Nature of biological clock

Chronobiologists have made numerous attempts to elucidate the mechanism of biological rhythms using numerous models and other types of investigations. Among them are studies employing the classical methods of studying the effects of removal of certain glands like the adrenals, etc. The results, however, point to no single regulator or anatomical structure that could account for the control of all rhythmic phenomena. The biological clock is, therefore, a physiological rather than an anatomical entity and consists of biochemical interactions. To simplify, it may be added that such a clock merely consists of continuous ebb and flow of certain known and unknown hormones in an organism. It is genetically evolved, and is already set, programmed and wound at birth. But it can be reset and corrected by certain external factors such as light, temperature, and possibly by yet unknown subtle geophysical forces.

After birth the biological clock starts unwinding and unfolding its built-in programme at roughly regular intervals, but, like mechanical automatic clocks, it has to be reset and adjusted from time to time. The following example proves this point.

The menstrual cycle in girls commences at 13-15 years of age and repeats at an average interval of 28 days till the menopause. The absence of light and dark stimuli of day-night cycle causes early commencement of menstruation (such as in blind girls), while the irregular light and dark stimuli of day-night cycle cause irregular menstruation (such as in air hostesses). This shows that the endogenous clock is created by conditioning or by imprinting on the nervous system during exposure to the environment. These biological rhythms, in hibernators, migratory birds and fishes, for example, provide better survival, more and easy food, better habitat, etc. So they become a genetically fixed pattern of behaviour in plants and animals by way of natural selection, and are passed from one generation to another through genes, the carriers of hereditary characteristics.

The existence of a daily clock led to speculations about the possibility of other endogenous rhythms, particularly an annual rhythm. French scientists Jacques Benoit and Ivan Assenmacher were the first to investigate and demonstrate the existence of such a clock. Other researchers in the U.S.A. confirmed the existence of such an endogenous annual clock in golden-mantled ground squirrel (*Citellus lateralis*), while studying the phenomenon of hibernation. They demonstrated that if these animals were not allowed to hibernate, even then they showed an annual cycle of alternating gain and loss of body weight. They reduced their food and water consumption and lost weight during the assumed winter and then resumed feeding and gained weight in the spring. Following Halberg's terminology, this rhythm has been called 'circannual'.

Eberhard Gwinner of the Max Planck Institute, Germany, discovered that like hibernators some migratory birds also possess a circannual clock. He noted that willow warblers and wood warblers, which breed in central and northern Europe. migrate in the fall to central and South Africa and return to Europe in the spring. He devised various elaborate laboratory and outdoor experiments and concluded that the yearly migratory cycle in these animals is more or less a rhythmic phenomenon. The differences in environmental conditions did not profoundly affect the bird's basic rhythm of migratory urge and molt. This example further illustrates the endogenous timing mechanism and its biological significance. A programmed duration of the migratory urge helps to ensure that migratory birds will arrive at a suitable habitat under any condition.

Biological significance

It is clear that the biological system is rhythmically changing and because of that the organism is biochemically a different entity at different circadian phases. It, therefore, reacts differently to the same stimulus at different times. These include chemical substances, like drugs and poisons; physical agents, like noise, light, cosmic rays. X-rays and gravity; and biological agents such as endotoxins, hormones, venoms, etc.

It is thus possible to use the knowledge of circadian phases to design treatment schedules that are more effective and less toxic so that therapeutic values of drugs are considerably enhanced. In fact, our ancient system of medicine utilized this concept of biological rhythms Ayurvedic drugs are administered at a particular hour of day, in particular combinations and with particular diet. Not only this, Charak, the father of Ayurveda, has gone a step further by advising that a patient of particular disease should be examined at a particular hour of day and after fulfilment of certain rituals.

Like circadian clock, the circannual clock also serves several purposes in animals. It provides advance warning of a coming change before signs of the change actually appear. For example, a hibernator starts accumulating fat and gains body weight before the onset of winter. Similarly, Siberian birds start depositing fat and gain body weight before they start migrating to Indian subcontinent. The innate circannual clock thus gives an animal time to prepare for annual events such as reproduction, cold weather, dry season, etc., so that it survives the temporary phase of adverse climate even if environmental cues or stimuli (temperature, light, etc.) are missing or not clear.

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How pressure-cooker works

GONE are the days of long, slow cooking of food which kept the housewife tied to the kitchen. Food is now cooked in a few minutes in a pressure cooker. Have you ever wondered how a pressure cooker works?

A pressure cooker is a labour and time-saving appliance, because it cooks food in only a fraction of the usual cooking time. The shorter time and the greater speed prevent destruction of food values. In industry,

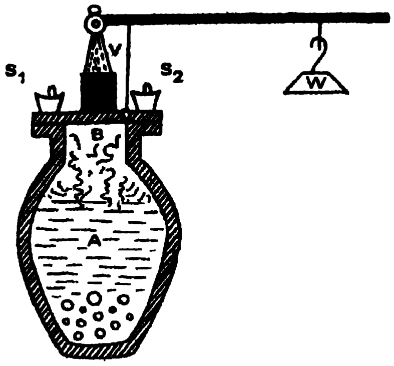


Fig. 1. The digester

pressure cookers like autoclaves are useful in quick cooking of food, particularly for 'canning.'

The cooking time depends very much on temperature, nature and size of the food. The food cooks quicker at higher temperatures. For example, an egg will take more time to cook in water at 75 °C than at its normal boiling point (100 °C). But if the temperature is raised too much, the food may even burn. Similarly, meat will take longer to cook than vegetables. Also, whole pieces take more time to cook than when cut into a smaller size.

Research has shown that the longer the food cooks, the more the food values are destroyed. The food values are mostly water soluble vitamins and minerals. In a pressure cooker, they are retained because a very small amount of cooking water is used. Also since the cooking is done in steam there is not much oxidation of the vitamins. So, the pressure cooker saves time, fuel and food value.

At higher altitudes, the air is rarefied, so the atmospheric pressure is low. Water, therefore, boils at a much lower temperature. Consequently, certain cooking processes are slowed down considerably; and it is not possible to cook meat, *dal*, etc., properly. If, somehow, the pressure on the water surface is increased, the boiling point can be raised. It is on this principle that the pressure cooker works. By boiling water in a closed container, the inside steam pressure increases and so does the boiling point of water. Fig. 1 shows a device popularly called a digester. *A* is a metallic vessel, with a lid *B*, containing the boiling water. The lid is kept fixed in position by means of two screws S_1 and S_2. There is a safety valve *V* which is controlled by a lever *L* carrying a load *W*. By shifting the load on the lever *L*, the pressure of the steam inside can be adjusted. The pressure cooker is an improved form of a digester which is provided with additional safety devices.

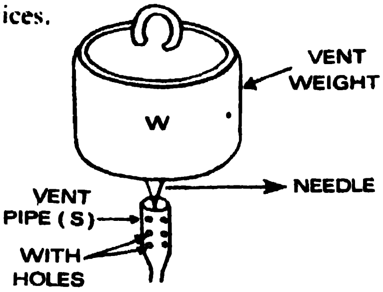
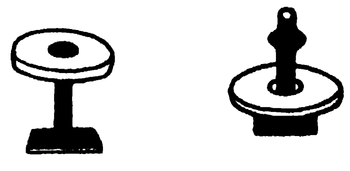


Fig. 3. Safety valve

The household pressure cooker consists of a rubber-gasket-sealed closed vessel *A* made of some strong alloy (Fig. 2) The



(a) CLOSED (b) OPEN

Fig. 4. Safety plug (R)

vessel is quite stout in design to withstand high pressures. There is a hole in the centre of the lid through which a vent pipe *S* passes. The vent weight *W* has a central needle which blocks the vent pipe when placed on it.

The steam cannot escape and so the pressure builds up inside the vessel. As the pressure increases the needle is pushed up gradually. When the pressure is too much, the vent weight lifts and allows the excess steam to escape through the vent pipe The vent weight thus maintains the correct cooking pressure beyond which it lets off steam. The safety plug *R*, which melts if the temperature goes too high, provides additional safety by releasing the extra

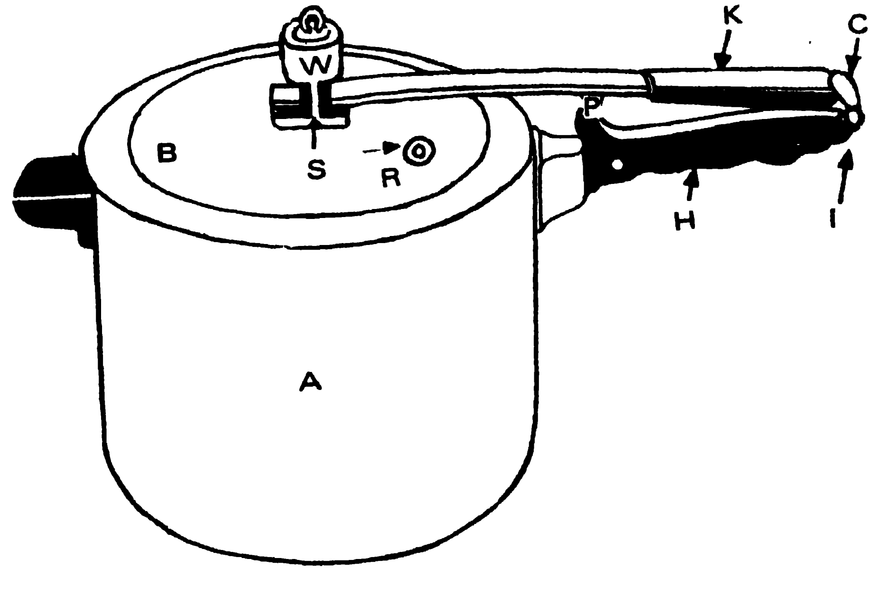


Fig. 2. Pressure cooker with safety devices

steam pressure quickly and automatically (Fig. 4b). The plug melts on excessive pressure or heat and can be replaced.

The time taken for different foods in a pressure cooker varies, but generally it is much less than necessary for normal cooking. By properly adjusting the time, even a complete meal of cereals, meat and vegetables can be prepared simultaneously in the cooker.

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Do it at home

Mini-calculator

HERE is a unique project which can do simple multiplications and division operations on a small scale. If you turn the control knobs to the numbers to be multiplied or divided, you get the result on the meter dial.

Analogue circuit

The computing device in this calculator is purely electrical. A 'passive' network of variable resistors is set-up whose voltage output indicates the desired output; the two numbers to be multiplied or divided are given appropriate resistance values in two variable resistors.

Potentiometer

The wire-wound linear potentiometer has three connections—one variable contact *B* and two end terminals *A* and *C* (Fig. 2).

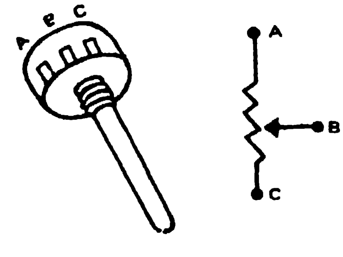

Fig. 2. Potentiometer

Meter

While connecting the voltmeter care should be taken to note the polarity of the terminals.

Operation

The angular movements of the controls *X* and *Y* are divided into ten equal parts which are denoted by the numbers 0 to 10 and each part may again be sub-divided into five or ten equal intervals.

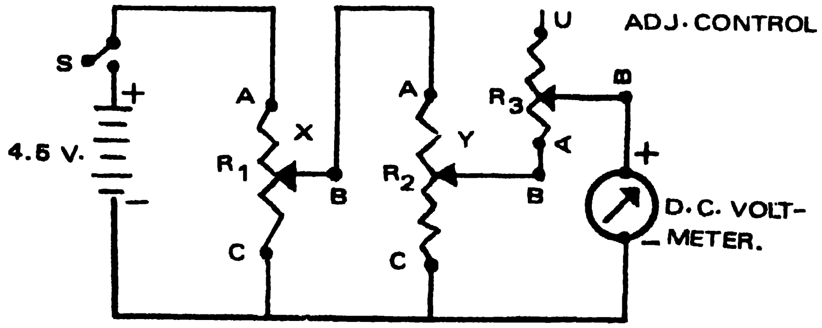

Fig. 1. Mini-calculator

Before using the calculator, keep the control knobs *X* and *Y* on the number 10 and set the adjustment control in such a position that the meter will read exactly 1.5 volt i.e., full scale deflection.

Now the calculator is ready for use. For multiplying the numbers 6 and 5, keep the control knobs *X* and *Y* on positions 6 and 5, then the meter will indicate 0.30 volt, which corresponds to 30. Division on this calculator is the reverse of multiplication. If you want to divide 72 by 8, then place one of the conrol knob, say *X*, on 8 and adjust the control knob *B* such that the meter will read exactly 0.72 volt. Then the number indicated by the control knob *Y* (i.e., 9) is the answer.

Requirements

V—One D. C. voltmeter 0-1.5 Volt 200 Ohms/Volt; R_1, R_2,—two 25 Ohm wire-wound linear potentiometer; R_3—One 0.5 K Ohms wire wound linear potentiometer; Battery—4.5 Volt (Three 1.5 Volt cells in series). Knobs, wires, slide-switch (on-off), and a suitable enclosure.

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Of pollen and spores

POLLENS and spores are reproductive bodies in plants. Pollens are produced in gymnosperms and angiosperms and spores by all lower plants, mosses and ferns. Externally, there is no difference between pollens and spores except that pollen has an opening pore or colpus, which is lacking in spores (Fig. 1). When the opening is circular it is called pore and when it is enlongated it is called colpus. The study of pollen grains and spores is called Palynology, a word introduced by British Scientists H. A. Hyde and Williams in 1944. It has been derived from the Greek verb *palynein,* meaning 'to scatter', since the pollen grainsand spores are often spread by the wind.

Palynology can be subdivided into two categories: Basic palynology, which deals with the morphology of the pollens and spores as well as the pollen production and dissemination, and applied palynology. The latter is further subdivided into a number of categories: (a) *Palynotaxonomy,* study of pollens and spores morphology in relation to taxonomy. It is of great use to plant taxonomists; (b) *Paleopalynology,* study of pollens and spores of fossil plants; (c) *Mellitopalynology,* study of pollen grains in honey, (d) *Pharmacopalynology,* study of spores and pollens in drugs; (e) *Iatropalynology,* study of allergy by pollens and spores; (f) *Forensic palynology,* palynology in aid to criminology; and (g) *Aeropalynology,* study of atmospheric pollens and spores.

Pollen morphology

Gymnosperms and angiosperms produce pollen grains which are not male gametes but carrriers, of male gametes. Pollen grains may be carried over by various agencies such as wind, water, insects and animals. After pollination they produce male gametes. A pollen usually consists of three concentric layers. The inner most layer consisting of protoplast disappears quickly if pollination is not achieved. The middle layer, intine, is a cellulose coat which is easily destroyed. The third and outer

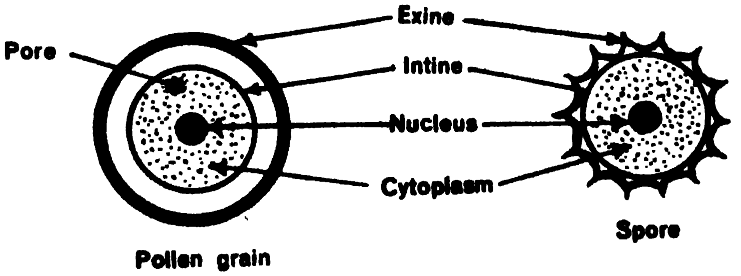


Fig. 1. Structure of pollen and

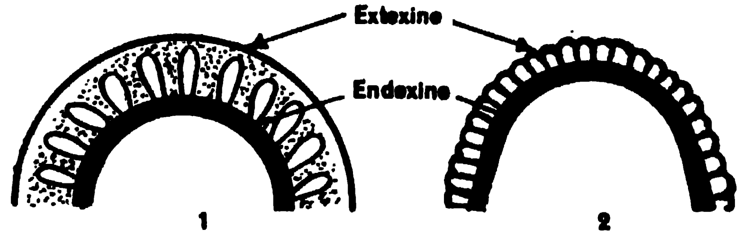
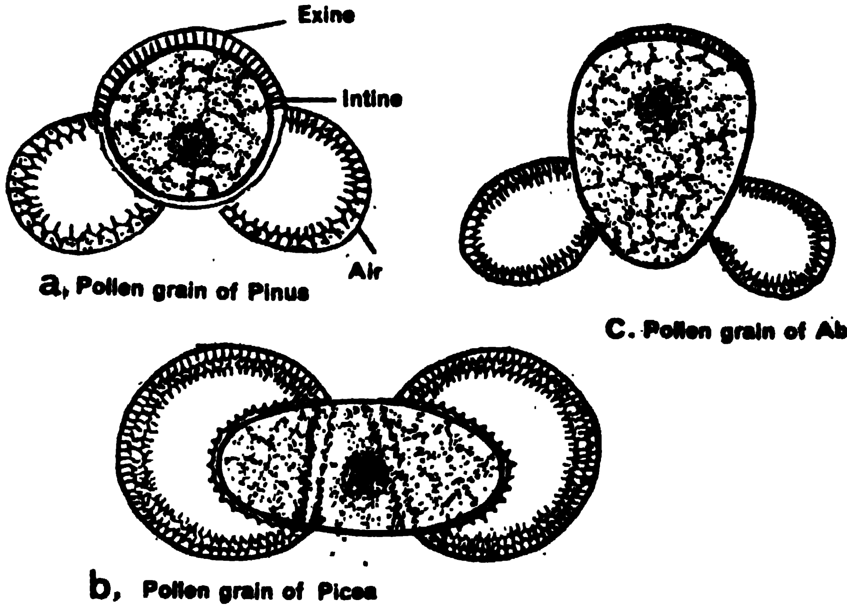


Fig. 2. Structure of exine



a, Pollen grain of Pinus

C. Pollen grain of Abies

b, Pollen grain of Picea

Fig. 3. Some Gymnospermous pollens

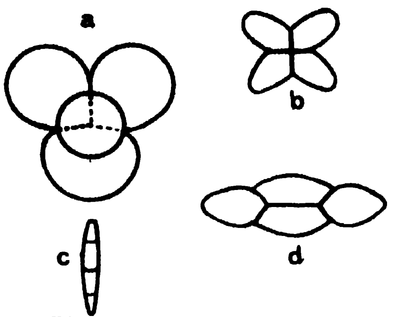
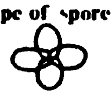
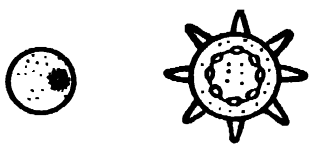


Fig. 4. Type of spore-tetrads





Figs. 5&6. Angiospermous pollens

layer is exine, which is a typically complex structure of great durability. It is the exine which survives ages of decay processes and lengthy chemical treatments. Its resistance to destructive forces is due to its in unusual chemical composition. It contains a highly polymerized cyclic alcohol called 'sporopollenim'.

Pollen grains have thin areas or openings in the exine layer through which the pollen tube emerges at the time of germination. The number of apertures varies from 1 to 100. A few species possess no aperture and the exine is spread over the entire surface. Such a pollen is called *populus.*

There is a great diversity among gymnosperms regarding pollens. The pollens of *Coniferales* have air-sacs. As most of the gymnosperms are wind pollinated, the air-sacs help pollens float in the air. In *Pinus*, pollen grains have two wings which are an extension of exine. In *Abietineae*, there are two air-sacs while in *Podocarpineae* there may be 1 to 6 such appendages (Fig. 3b).

Size of pollens

Pollen grains in angiosperm range from about 5μ (1 micron $=10^{-4}$cm.) to over 200 μ in diameter. Most grains fall in the range of $25\mu = 100\ \mu$. Families, *Boraginaceae*, *Piperaceae* and *Cunoniaceae* have pollens of the smallest size while *Dipsaceae*, *Nyctaginaceae* and *Oenoteraceae* have the largest pollens. The pollens of *Zostera*, and aquatic species of monocot, resemble a membranous tube. They are over 2500 μ in length and only 3-4 μ in width. Size of pollens is directly linked with their numbers. The larger size of pollen grain, the lower is the number of pollens in a *locule* and vice versa. For simple, in Mirabilis large pollens of 32 grains per loculus occur while minute grains of Borago probably exceed 50,000 per loculus.

Spores

Spores are produced in lower plants like, algae, fungi, bryophytes and pteridophytes. They are single-celled or multi-celled reproductive bodies that become detached from the parent and give rise either directly or indirectly to a new plant. Spores are produced in a group of four tetrad and are not completely spherical (Fig. 4).

Structural modification

Pollen grains dispersed by water lack exine and have no special attaching structures. Windborne pollen grains and spores are small. and smooth-walled (Fig 5). They may or may not have air-sacs. Pollens and spores carried by insects or animals are generally adhesive and their exine bears prominent protuberances (Fig. 6). Palynologists have estimated that distance covered by pollen grains and spores during dispersal generally ranges from 100 to 130 kilometers.

Economic importance

Besides their role in the propagation of a plant, pollens are indispensable as food material for the bees. All pollens do not have same food value. Their protein content varies from 7%-11% in pine, to 35% in datepalm. The average fat content ranges from 1% in birch to 17.5% in black walnut. Bee-collected pollen is said to be an excellent source of vitamin B and C, as well as vitamin D and E. Vitamin A and K are, however, not known in pollen grains.

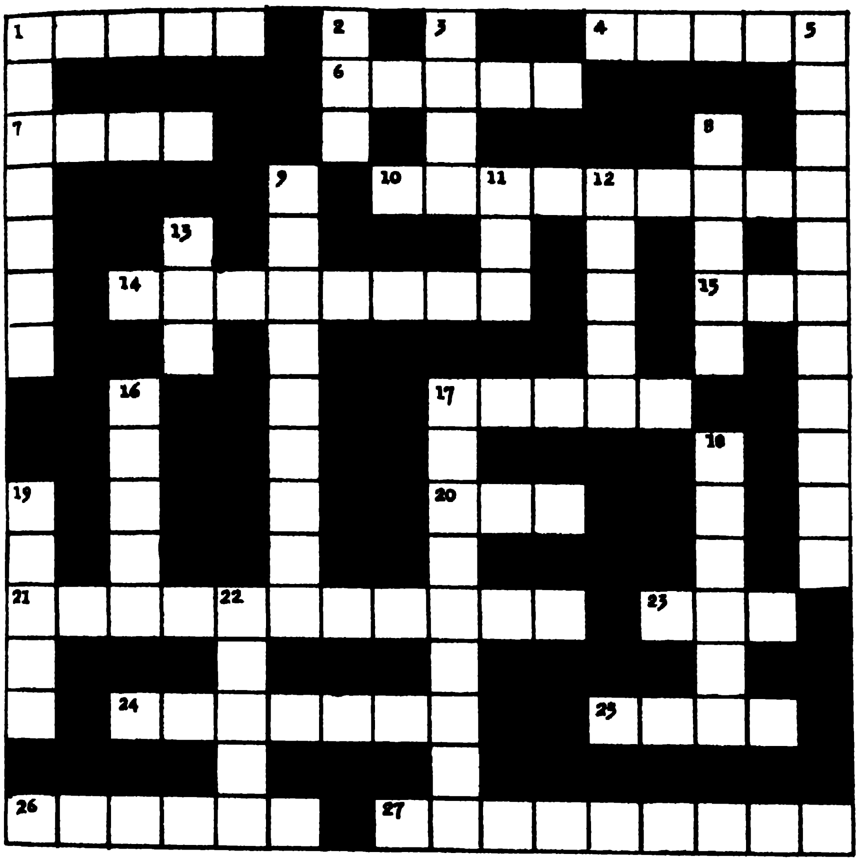
Many people are sensitive to pollens of certain plants, particularly grasses and ragweeds. The allergy caused by them is popularly known as hay-fever. Fern spores are also suspected to cause allergy.

Anil Kumar
Sunil Chaturvedi

Solution to wheelword puzzle published in August 1977 issue

The rim (Clockwise): (1) Atropa (2) Inula (3) Datura (4) Uvaria (5) Mimosa (6) Ixora (7) Ocimum (8) Nerium.

The spokes: (Names begin from centre, C); (1) Curcuma (2) Clitoria (3) Coriandrum (4) Capsicum (5) Cuminum (6) Cannabis (6) Calotropis (8) Cinchona



Science Crossword Puzzle (Fish and fisheries)

CLUES

Across

1. A multitude of fish swimming together.
4. Generic name of the fastest growing indigenous freshwater teleost.
6. A mass of eggs, of fish or frogs, laid in water.
7. A long-winged, web-footed fish-eating bird of the sea coast, rivers and estuaries.
10. The only known living representative of the great group of fossil fish, *Crossopterygii*—a coelacanth.
14. An angler.
15. A snake-like fish with a smooth slimy skin.
17. Name of the research centre (abbreviation) conducting scientific investigations for an appraisal of the inland fisheries resources of the country and for evolving suitable methods directed towards their, proper conservation, management and development.
20. A standard and highly relished fish dish of Japan which at the first glance creates a picture of biting through scales, fins, and bones while the fish squirms in your grasp.
21. The branch of natural history that deals with fishes.
23. Young ones of carps upto 2.5 cm in length.
24. An exotic fish which was introduced into India in 1952 from Bangkok. It is a prolific breeder and exhibits buccal incubation.
25. Roe of male fish.
26. Generic name of a well-known perch notorious for its habit of climbing the trees.
27. The process of pressing out ripe roe or milt of fishes for artificial fecundation.

Down

1. Largest of the three otoliths (ear stones) which often comes handy for determining age and growth of fishes.
2. Name (abbreviation) of one of the two important hormones contained in pituitary gland which influences maturity of gonads in fishes.
3. A miniature tank-like structure made up of cloth, and fixed to poles in water for temporary storage of fish and fish seed.
5. A newly coined word for describing far-reaching recent advances in freshwater fish culture technology.
8. An angler's fish bag.
9. A term for describing the number of ripening eggs in the female fish prior to the next spawning period.
11. A famous game fish found in hill streams and upper reaches of rivers in the northern latitudes of the country.
12. An important freshwater air-breathing catfish of great commercial value.
13. The organ by which the fish maintains its equilibrium and swims.
16. Irrigation tank of certain south-western districts of West Bengal in which major Indian carps breed during rainy season.

(Continued on page 602)

FOR HER

A slim figure—how to maintain it

OBESITY, of course, is the result of excess fat. How does fat accumulate in the body ? Mostly through what you eat ! The food you eat supplies part of the immediate energy demands of the body. The surplus is converted into fat and stored in the body in various regions; under the skin, in the abdominal region, behind the eyes, etc., to be used later in times of need. Besides being fuel reservoirs in the body, fats have several other functions. They form an integral part of all body tissues. They help in the absorption of fat-soluble vitamins, and also insulate the body. The extra padding supplied by fats helps protect delicate organs. And if it were not for the subcutaneous fats, you would be just skin-and-bones.

The storage of fat is a continuous process: as the stock gets depleted, it is replaced by a new stock. But when the replacement bulk is larger—this could happen due to overeating or underactivity—the stocks build up. The result is obesity.

Usually the magic key to a slim figure is cultivating the right eating habits. But, then, you'll argue : What about genetic factors, hormonal disfunctions and glandular diseases that lead to obesity ? True, hormonal and glandular diseases could lead to an extra padding. Most people blame their genes or glands for their fatness. But only a few—very few—are justified in this. Now, why do most fat people overeat? There can be several reasons. Upbringing, for one. Some mothers feel satisfied only when their children learn to leave a clean plate after meals. Such people get accustomed to large doses of food. Another reason for overweight is eating rich foods like ghee, butter, nuts and sweets. Eating to compensate for disappointments and sorrow, or eating out of boredom and shyness, are other important factors. The tendency towards obesity in women around menopause is mainly due to the insecurity and feeling of being unwanted. This again leads to overeating.

How can you maintain a steady weight ? Biochemists and doctors suggest dieting: A protein-fat-rich diet that excludes carbohydrates, or a diet that does away with fat, or one in which one of the components is cut down to the minimum. Proteins and carbohydrates yield about 4,000 cals. per gram, but fat yields 9,000 cals. per gram. A balanced diet is the first condition. Again, spreading the meals over the day is conducive to slimming. Dieters should not skip meals. But if you are on a reducing diet, you should take care to ingest all the necessary body requirements like vitamins, minerals, etc. Exercise is an effective way of reducing but it also acts as an appetiser. Provided you take care not to increase your food intake, exercise should help. You can also try selective slimming (e.g., around the waist, the hips, etc.) through proper exercises.

It is easier to control body weight in the early stages of active fat accumulation. Permanent reduction becomes difficult once the stationary passive stage of obesity is reached. Can you do it with pills ? Some doctors and some beauty clinics will say, Yes ! If you can throw money in a beauty clinic, it is alright. While you are at it, the diet, exercise, massage, sauna bath—they do help to slim. But come back to normal life and you'll get back your normal figure! But with a proper diet and regular exercise you could achieve similar results at home.

There are drugs to reduce appetite. These drugs—usually of the amphetamine group—act on the brain and are positively dangerous. They are habit-forming drugs. In selected cases of obesity, plastic surgery may be resorted to. However, the operation is a major one in which the fat from one site is removed. But proper dieting and regular exercise are the easiest and safest means to maintain a slim figure.

SUBHASH C. DUTTA
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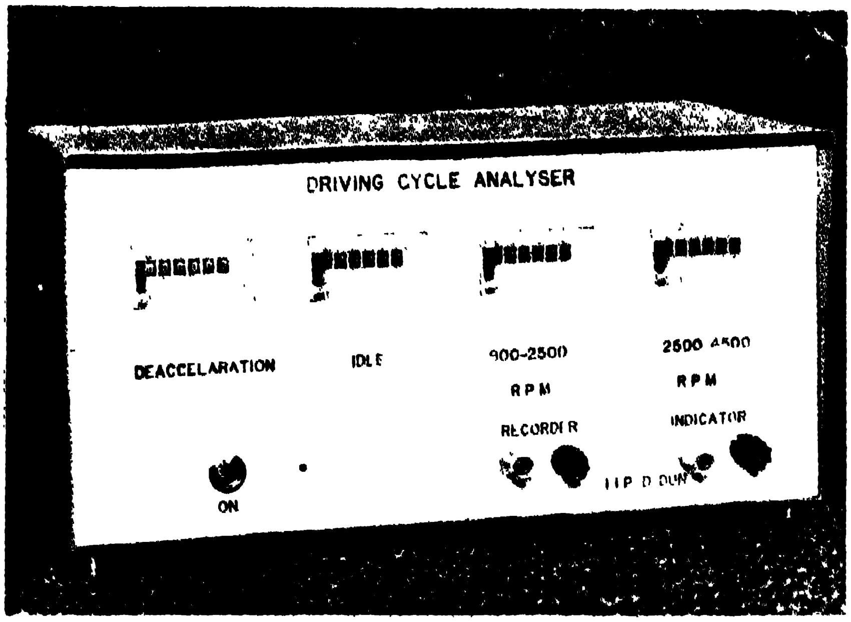
CLUES (*Continued from page 601*)

17. A fish-eating water bird which dives in to catch fish. In Japan, this bird is tamed and used for catching 'Ayu' (sweet fish).
18. A group of air-breathing fishes popularly referred to as 'snake-heads'.
19. A large, vertical fishing-net whose ends are brought together and hauled.
22. A well-known anadromous migratory fish, a denizen of the Bay of Bengal, which ascends for breeding in shoals into the Ganga-Brahmaputra, Mahanadi,Godavari, Krishna,Cauvery, Narmada and other streams.

NIRMAL K. THAKUR
Air-breathing Fish Culture Unit
Central Fisheries (ICAR)
Laheriasarai-846001
Darbhanga, Bihar

Science in Industry



Driving cycle analyser developed at I.I.P.

THE Indian Institute of Petroleum (IIP), Dehra Dun has designed and developed a Driving Cycle Analyser for the first time in the country. The apparatus is useful in estimating and forecasting accurately the fuel saving or exhaust emissions in vehicles and in studying the changes in engine, design on the emissions and fuel saving. The instrument will be useful in developing and standardising a driving cycle for the country based on the traffic condition, pattern and driving habits of our people.

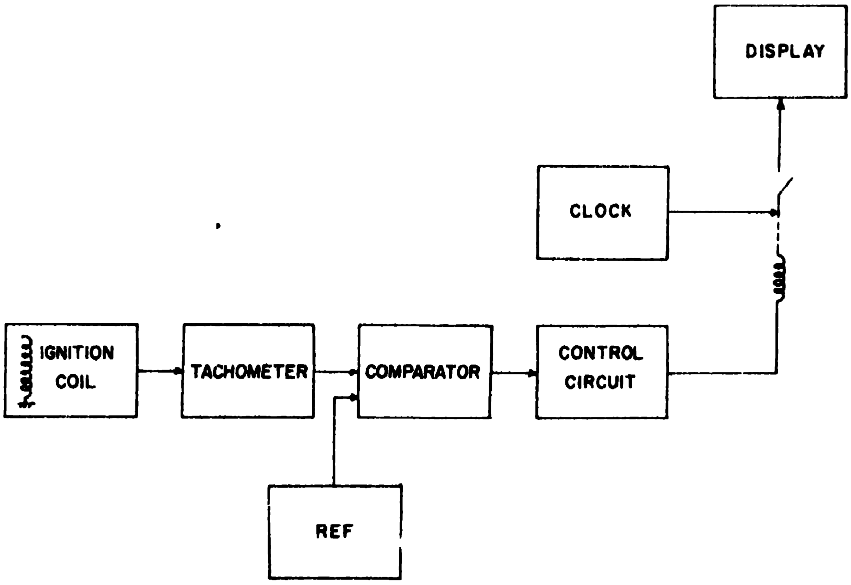
The Institute plans to conduct trials in the major cities for the purpose. Though primarily meant for developing and evaluating driving cycles, the instrument will also be useful in assessing the driving capabilities of drivers. With the information on driving habits, the transport authorities can accurately judge the fuel-saving capability of the drivers while issuing driving licences and thus help in saving a substantial amount of fuel.

The instrument essentially consists of three parts: (i) Electronic clock, (ii) RPM sensing unit, and (iii) Comparator. The electronic clock, which is capable of measuring one-tenth of a second, is connected to different displays of the instrument depending upon the driving conditions of the vehicle. The speed signal is picked up from the ignition coil.

The instrument is compact, light weight, reliable and has adequate accuracy.

The specifications of the Driving Cycle Analyser developed at I.I.P. are :

Accuracy :
(i) Time : 0.5%
(ii) RPM : better than 1.5%
Range (0 to 5000 rpm.)



New metal products developed

SOME National Laboratories under the Council of Scientific & Industrial Research have produced new products from metals available in India. These metal products and know-how have great industrial potentials.

For instance, the National Metallurgical Laboratory, Jamshedpur, has developed a simple and economical method for the production of foam metal in response to the increasing demand for light-weight materials for construction.

Foam metal is used as an energy absorption material to act as a shock absorber in railway coaches and automobiles, as a filter material, as a bearing material when used in the form of a composite and as electronic packaging material.

The laboratory has also developed an inoculant called PM-120 to produce commercial aluminium and aluminium alloy castings of good quality. The inoculant has been found useful in producing commercial fine-grain aluminium and in improving the mechanical properties of the aluminium alloys.

The Regional Research Laboratory, Bhubaneswar, has developed a process for the production of electrolytic iron powder from waste iron scrap. High-purity iron powder finds applications in flame cutting, chemical and automobile industries, and in the manufacture of welding electrodes, etc.

The new process has been studied on a bench scale, and 200 g of iron powder per day have been produced in the laboratory.

The National Aeronautical Laboratory, Bangalore, has developed an electroless tin plating bath for printed circuit board applications.

This bath also finds application in tin coating of pins, screws and nuts. At present tin plating is done by utilizing imported technology and so far no satisfactory electroless tin plating bath was available in the country.

All the raw materials for the new process are available indigenously. The bath is estimated to cost Rs. 24/- litre.

The National Chemical Laboratory, Poona, has developed a process for the manufacture of fumed silica. Fumed silica is a special chemical which finds extensive applications in many industries such as aerosols, adhesive, cosmetics, insecticides, lubricants, rubbers and textiles.

ANESTHESIA *(Continued from page 566)*

Electronarcon is a very recent method of childbirth without causing any pain to the woman. It has been successfully tested in the USSR. In this method an apparatus is used whose pulse currents kill labour pains even in the severest cases. It kills pain but is not an anesthetic. Muscles are not released but the feeling of pain is absent. The new method has several advantages over the use of the narcotic pain-killers which cause foetal numbness and protract the birth. It is also convenient and inexpensive. The inventors of the apparatus claim that it can also be made use of for other patients during surgical operations. The patient can be brought back to normal consciousness within a minute or two and can breathe normally.

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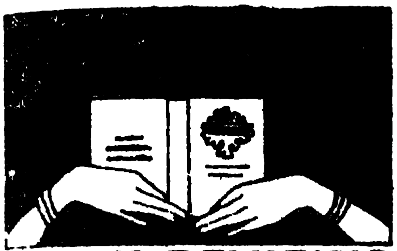


BOOK REVIEWS

BUILDING SCIENTIFIC INSTITUTION IN INDIA: SAHA AND BHABHA.

by Robert S. Anderson, *Centre for Developing Area Studies,* McGill University, Montreal, Canada, Rs 16.00

THE book under review studies the growth of scientific community in India and its relation to the political economy by comparing and contrasting the lives of two of India's foremost scientists and scientific institution builders—Meghnad Saha and Homi Bhabha. Here, while portraying these two men of science, the author attempts to trace the social, economic and political environments in which they grew up and how these influenced them in their attitudes and thinking processes. More than that "by pulling together little known threads of history it provokes some basic thinking about the science policies appropriate for developing countries." By studying these two scientists, the author Robert S. Anderson raises an issue which is of importance to us today, as to what should be the proper institutional model for India—one derived from metropolitan countries or the one built using local Indian experience.

Meghnad Saha and Homi Bhabha were two very strikingly different personalities. Although judged by the contributions made by them to their respective disciplines, physicists generally are of the opinion that Saha's discoveries are more epoch-making and extensive than Bhabha's—but that is not the main topic of discussion in this book. Here these two personalities are drawn, on a large canvas, more as scientific institution builders and their attitudes and outlooks towards building these institutions.

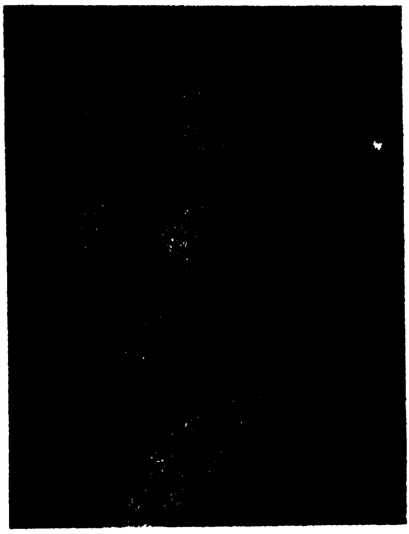
Saha was indeed a typical Bengali and was fully Indian in image. One of the eight children of a poor shopkeeper of an East Bengal village and born in a so-called 'low-caste' family, Saha was trained up at a time when Bengal was providing leadership to the country's struggle for independence. No wonder he became a nationalist to the core. He was expelled from school at the age of 12 in 1905 for boycott, which later debarred him from appearing at the Indian Finance Service Examination. But he had had the advantage of growing up in the best social and academic traditions of the country at that time. His professors and colleagues included almost all the luminaries of Indian science—Sir J. C. Bose, Acharya P. C. Ray. Sir C.V. Raman, P. C. Mahalanobis, S. N. Bose, S. K. Mitra, and others, besides political figures like Subhas Bose, Rajendra Prasad and the famous revolutionary "Bagha" Jatin Mukherji.

Compared with this, Bhabha came from a rich Parsi family and grew up in an aristocratic world of "books, music and painting—all supported by business and industry". Bhabha was educated at Cambridge and was tutored by Paul Dirac in Mathematics. He was trained in theoretical physics at the Cavendish Laboratory and then worked in the Institute at Copenhagen which housed Neils Bohr's group. So Bhabha's complete socialisation into the scientific community occurred in the most active centres in the hottest field of physics. He stayed back in India, where he had come on holiday in 1939 because of the War breaking out in Europe. How different this world was from Saha's !

M. N. Saha

The author critically examines the background of these two organisers of scientific research, since their views were largely influenced and moulded by these factors. The author's attempt to establish the relationship between the totality of the environmental backdrop and how it affected their attitudes and sympathies makes the book all the more interesting. And no doubt, the author has succeeded in this hard, if not pioneering task, which in lesser hands would have taken a different shape altogether.

Saha was more concerned with the "problem of living for India's millions" which compelled him to enter parliamentary politics in addition to his continued involvement in scientific associations and laboratories. Bhabha was clear in mind that specialisation was absolutely necessary and to him the "problem of living" was of lesser concern than the necessity to build up schools of pure and applied research which might be useful in dealing with that problem.



H.J.Bhabha

The circumstances of Saha's leaving the University of Calcutta, joining the Allahabad University and making it an important centre of research, founding of the United Provinces Academy of Science, the gradual increase of his national influence, his criticism of Gandhi's plan for cottage industries and his belief that "Congress leaders were puppets in the hands of big industrialists, most of them foreigners" (which was repudiated by Nehru as "really extraordinary"), have all been described with meticulous care. Then are discussed with ample details how Saha organised the Palit Laboratory of the University of Calcutta, founded the Institute of Nuclear Physics and helped the growth of research groups at the Instiute and what tremendous problems and hardships he had to face in this process. Saha never took science as an end in itself but as a means to improve the living conditions of the country's millions. Disappointed with the Government policies on education, industrialisation, health, river-valley development and planning, he "decided to offer himself" as a candidate in the first general election because he firmly believed that "this insistence on primitive technology shows a very retrograde and anti-scientific mentality, and persons who are wedded to this mentality would bring disaster to the country when they are in power". Of this Saha, one knows and understands very little. Thanks to the author, he has brought to light many little known facets of Saha's career and analysed them without ever losing sense of perspective.

Similarly, the author tells us how Bhabha, "caught in India by the War", worked on cosmic ray research at the Indian Institute of Science, Bangalore, founded the Tata Institute of Fundamental Research and organised the School of Mathematics there (on the advice of his tutor Paul Dirac that a School of Physics could not grow without a School of Mathematics) and proposed the formation of the Atomic Energy Commission. The AEC was founded in 1948 with Bhabha as the Chairman, S.S. Bhatnagar as Secretary and K. S. Krishnan as the third member. In 1954, the "Atomic Energy Program expanded its status from Commission to Department of the Government, and Bhabha also became a Secretary to the Government of India, and the DAE was to execute the AEC Policy". Then are discussed in great details Bhabha's influence on Nehru, his all-pervasive influence on the science policy-making at the national level, development of the Atomic Energy Commission as also of TIFR. "Both Saha and Bhabha began their institutions with a mixture of private, state government and central government support. But TIFR was the cradle of the atomic energy program and SINP was not an essential part of either of the two networks of laboratories promoted by the government—CSIR or DAE. TIFR naturally had priority in DAE through Bhabha's joint position. SINP was forced, in Saha's life-time, to depend completely on DAE".

Saha quite severely criticised Nehru whereas "Bhabha got almost everything through Nehru, and embodied most of his values". Saha believed that efforts to increase the source of power (by exploiting the rivers, for example) which did not also increase self-reliance significantly were not correct. But Bhabha saw power in nuclear fission and believed "that for the short run it was simply necessary to import the models which could be adapted and reproduced in India, in order to gain time and ensure training". But Saha did not have much faith in the policies "of expediency and compromise". This symbolises one fundamental difference in the opinions of Bhabha and Saha which the author has very carefully shown while analysing their attitudes towards science policy-making in India.

But the author does not attempt to provide a complete answer, nor is it possible, to the questions that have been raised at the end of the book. Questions like "What is the source of difficulties in the growth of our scientific institutions ? Is it the imperfect socialisation of newcomers to the scientific tradition ? Is it 'cultural weakness' ? Or, is it 'inadequate organisation [illegible]" If a specialised, purportedly national institution becomes localised through provincialisation, does it inevitably experience the difficulties which troubled Saha's institute ?" quite often come up in our minds These are problems faced by most of the developing countries of the world. It is almost impossible to provide any unique and straight-cut solutions to them, no is it the intention of the author But he has succeeded in providing some extremely valuable insights into these problems which will make the reader more aware of them and equip him better to think about the whole issue.

This very well written book is a mine of information and deserves a place in the book-shelf of every educated Indian who has the lightest concern for the development of scientific institutions and traditions in the country.

AMITABHA BHATTACHARYA

A DICTIONARY OF CHROMATOGRAPHY *by* R. C. Denney, *Macmillan*, Representive in India *Macmillan Co. of India*, 2/10, Ansari Road, New Delhi-110002, Pp. 191, £15.00.

THE technique of separation by chormatography was discovered by Tswett in the first decade of the present century. But it was not until the 30's that the method was put to practical use. Since then there has been several refinements and today various forms of chromatography are used in both analytical and preparative chemical practice and also in a large number of industrial processes.

As with many other fields of science, the rapid expansion of chromatographic techniques called for new terminology. In many cases new words had to be coined, while in others specific meanings had to be assigned to the known words to express the ideas in precise and unambiguous terms. Denney's book contains some 500 such words and terms frequently used in chromatography. They range from simple abbreviations like DMCS, FID, PTGC, etc., to detailed descriptions like those on Detectors, Counter-current method, the various types of Thin layer chromatography, Zone electrophoresis, etc. Over fifty well-drawn diagrams are a good aid to explaining many of the terms. A long list of reference is provided at the end.

Some of the 'explanations' in the text are, however, vague. Some could have been easily done away with. For instance, under the term *Vapour phase chromatography* it only says, "This term is no longer employed generally for what is now called gas chromatography!"

Some are too full of jargon. For example, *Electrophoresis* is explained thus: "There are four related electrokinetic phenomena involving the relative movement between the two parts of an electric double layer. Of these four phenomena, electrophoresis is the movement of the charged surface relative to a stationary buffer solution arising from an applied electric field." The author does not explain what *is* an electrokinetic phenomenon, what are the other three such phenomena, or what is an electric double layer. (For comparison, I found the following in a contemporary book on the subject: "The migration of electrically charged solute particles present in a colloidal solution towards the oppositely charged electrodes when a voltage is applied across them"). There are many such examples.

Another minus point about the book is its prohibitive price. The author claims that the book has been written for the student, laboratory technician or general scientist. But one wonders how many of them will be in a position to invest £15.00 for this not quite informative volume.

BIMAN BASU

THE THEORY OF RELATIVITY *by* R. K. Pathria, *Pergamon Press*, Headington Hill Hall, Oxford OX3 England, Pp. 313, $ 24.00

THIS book is one of the monographs originally brought out by Pergamon Press under the international series of monographs. Clear expression of the subject and the simple way in which the book has been written are an indicator of the in-depth experience which the author has in the field. Besides giving mathematical expressions involved in the theory, he has also given adequate physical ideas to explain various aspects of the subject. There is a balanced blend of mathematics and physical ideas. Mathematics has not obscured physics, as it may and usually happens in works like the present one. For this reason, the book will be useful to students and those who want to grasp the foundation of the subject.

To keep a track of events which led to the modern concepts of the theory of relativity, the author has given separately the historical account which gives the background of the development of the subject starting from Rene Descartes' '*aether*' to the 'Special Theory of Relativity' and then to the evolution of unified field theory.

The book has been divided into two parts. The first part containing the Special Theory of Relativity, covers topics ranging from space-time transformations and four-dimensional formulation of the theory to the application of this formulation and consequent modifications in the fields of mechanics, optics and electromagnetism. General Theory of Relativity dealing with the systems of reference in arbitrary motion, has been explained in a lucid way in the second part of the book. Other salient features of this part are: Experimental Tests of Einstein's Theory of Gravitation and Relativistic Cosmology. Inclusion of a variety of unsolved problems at the end of each chapter and foot-notes for reference also enhance the utility of the book. Some concepts of differential geometry of a curved surface have been given separately in the appendix.

On the whole, the book is a commendable work of Dr. Pathria and can well serve as a reference as well as text-book for post-graduate students.

R. K. BHATNAGAR

HANDBOOK OF THICK FILM TECHNOLOGY *by* P. J. Holmes and R. G. Loasby, (Eds)., *Electrochemical Publications Ltd.*, 29 Barns Street. AYR, Scotland, Pp. 430, $57.50.

THE book under review aims to provide all the information about the manufacturing process of circuits. There are contributions by eleven scientists actively engaged in the field which provide a pool of information collected over years of experience. They discuss the processes used, and the equipment necessary for the production of thick film printed circuits. The merits of some of the alternative designs have been outlined in the chapter on the deposition process equipment.

The basic substrate materials and their formulations have been discussed together with the processes for fabricating the substrate. In the chapter on characteristics of resistors the design considerations, fabrication, performance reliability and the rules for design and location of resistors have been described. Several ranges of materials have been reviewed and some of the recent developments in high strength materials and low cost base metal conductor composition are discussed in detail.

·The book is well illustrated, and contains numerous tables which are useful for quick reference. The most important feature of the book is that it provides a big list of up-to-date references at the end of each chapter. The editors have here only repeated the matter at various places. The book will be useful to practising technologist.

VIJENDER SHARMA

OPTIMIZATION TECHNIQUES FOR CHEMICAL ENGINEERS *by* Asghar Husain and Kota Gangiah, *The Macmillan Company of India Ltd.*, 2/10 Ansari Road, New Delhi-110002. Pp. 317, Rs. 18.00

NEARLY every engineering system design needs optimisation for optimum system performance. The engineers and technologists engaged in theory and development of technology require optimization techniques to determine optimum design parameters. The present book gives greater emphasis on nonlinear optimization techniques, because the open ended real life problems are, in general, nonlinear in nature.

The subject matter is organized in two parts, viz., function optimization for static systems and functional optimization for dynamic systems. The first chapter, which serves as an introduction, reviews the development of optimization techniques as it has been applied to engineering problems. A discussion on various terminologies is also included. In early chapters, various methods for unconstrained and constrained optimization of function of lone variable and several variables are treated in detail.

The development of the concept is smooth and accompanying problems, derived from chemical engineering, are extensive. The comparative tables present insight into various techniques.

The second part on optimization for dynamic systems includes chapters on dynamic programming, variational methods and difference method for time domain.

Throughout the book, the treatment of the topics is invariably rigorous, without being pedantic. The authors write with clarity and because of their experience with the subject they are able to give valuable insight as to why a certain technique will work in some situation and not in others.

The references given at the end of each chapter will lead research workers in the field to detailed background material.

Although the book is written for chemical engineers, it will serve as a reference for those working in other disciplines.

A. K. SHARMA

TRANSISTOR SWITCH

(*Continued from page* 561)

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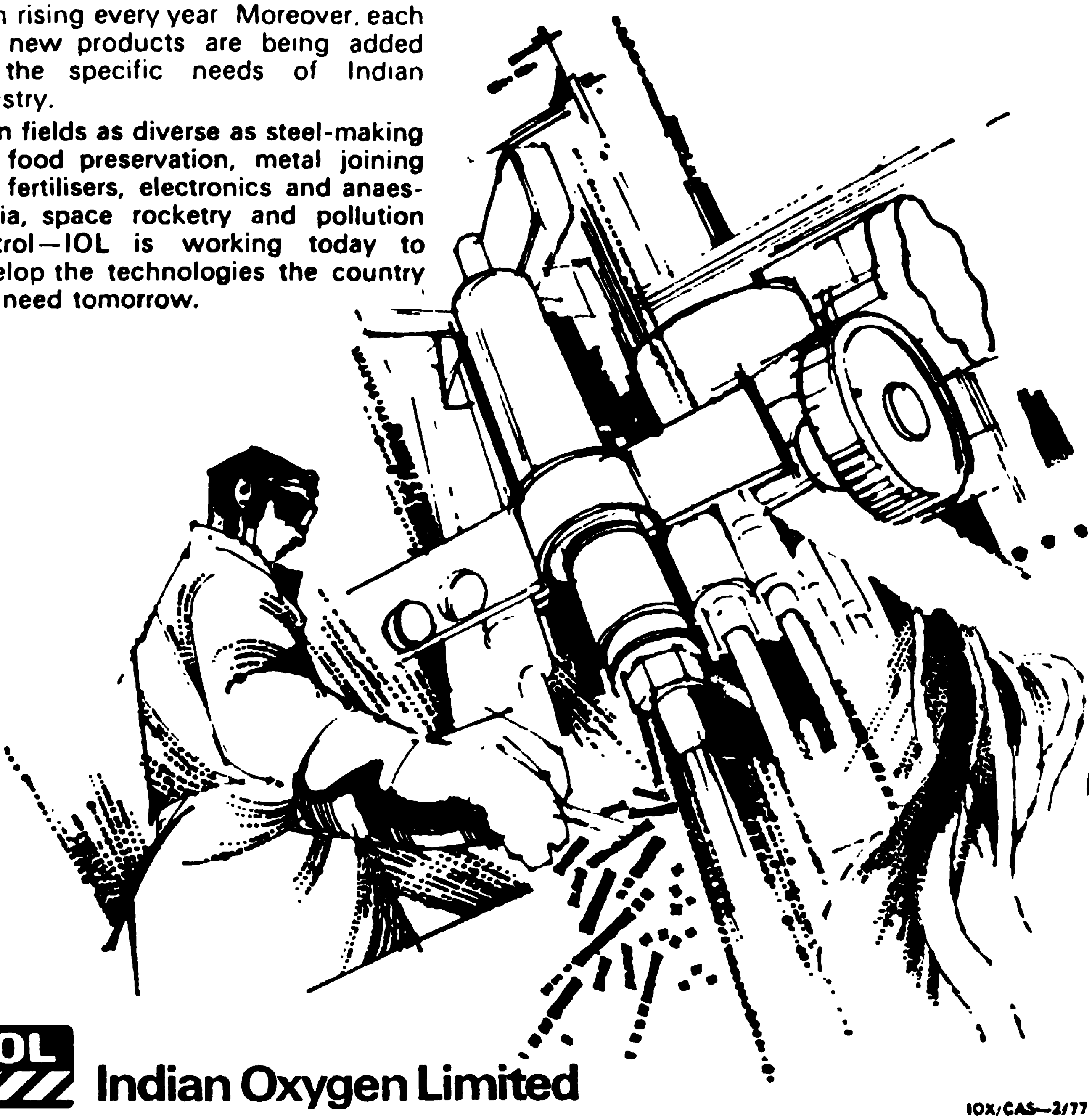

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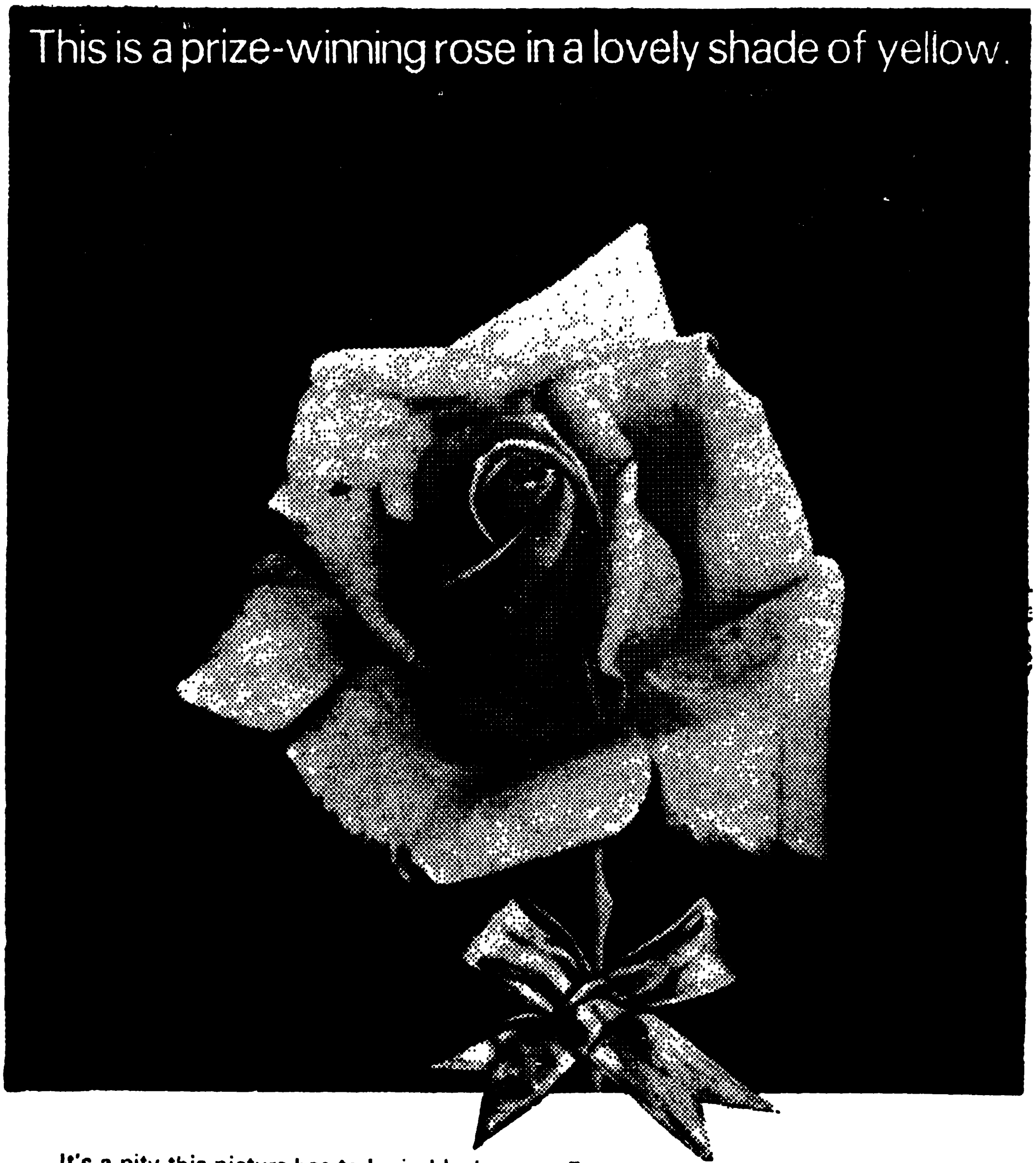

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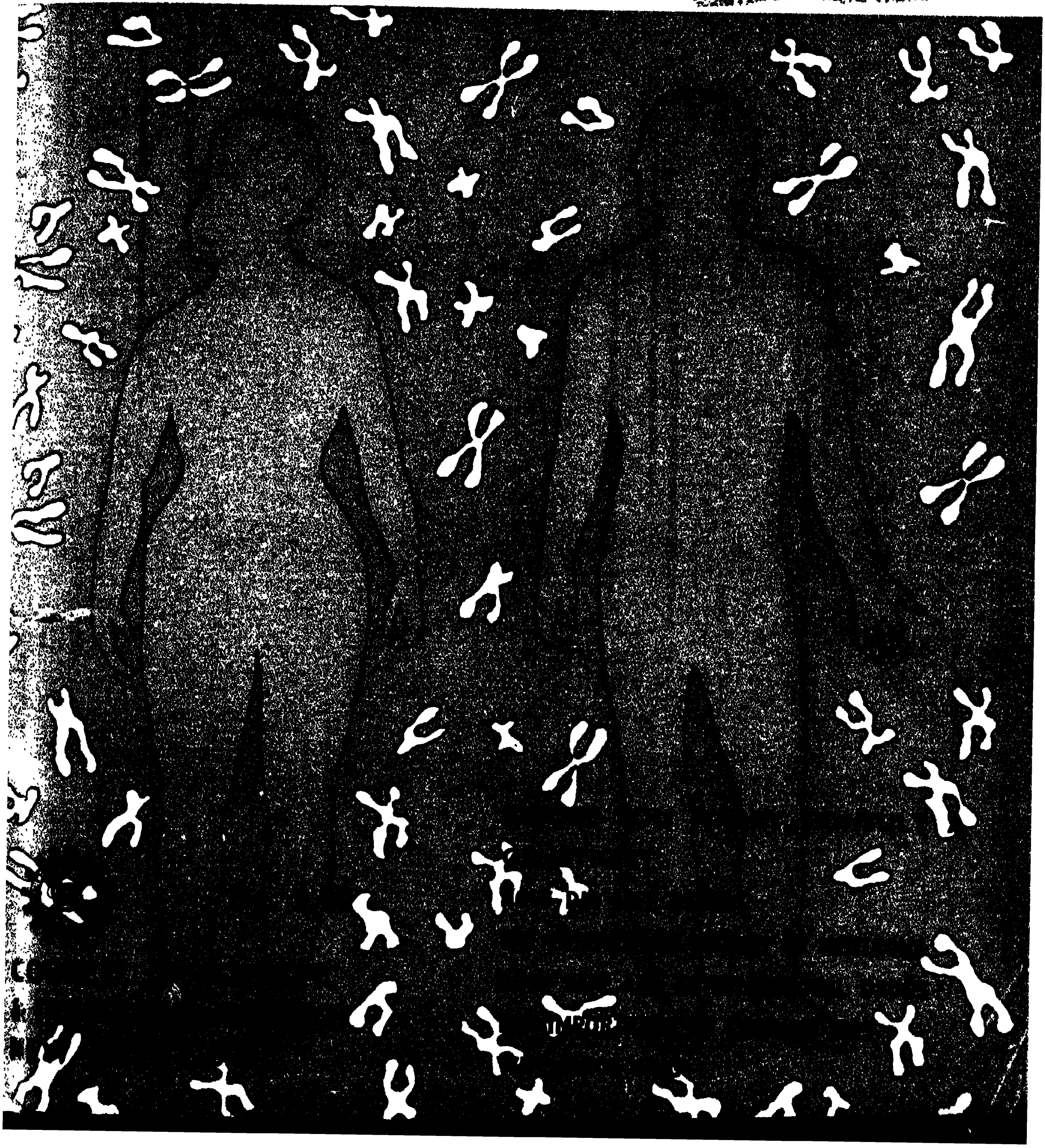

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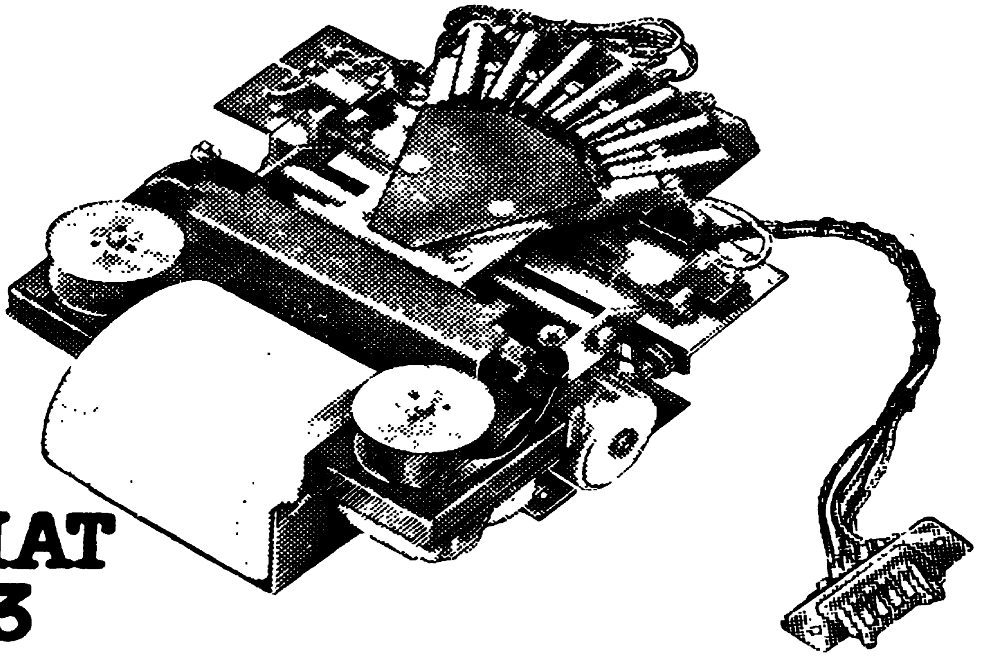

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LETTERS

Science Congress 1977

Sir, It has been painful for me to go through the sweeping and damaging remarks levelled against the 64th Indian Science Congress held at Bhubaneswar in January, 1977, in your magazine (*S.R.* February, 1977). The session has been branded as dull, uninteresting, and a wastage of time, national wealth and science talent.

The session was attended by about 2600 delegates drawn from all over the country including 51 foreign scientists representing well-known scientific organizations in different countries of the world. More than 400 papers were read in 13 sections, most of them by young scientists. Dr. H. N. Sethna, Chairman of the Atomic Energy Commission, was the General President and the thirteen sections, namely, (1) Mathematics, (2) Physics, (3) Chemistry, (4) Botany, (5) Zoology, Entomology and Fisheries, (6) Anthropology and Archaeology, (7) Medical and Veterinary Sciences, (8) Agricultural Sciences, (9) Physiology, (10) Psychology and Educational Sciences, (11) Statistics, (12) Geology and Geography and (13) Engineering Sciences, were each presided over by an eminent specialist in the field. In addition, presentation of papers was also done under the Committees and Forums: (1) Science and Public Relations, (2) Science and Economic Development, and (3) Home Science and Nutrition. The focal theme for the session was survey, conservation and utilization of resources, under which discussions were held and a very educative exhibition was arranged. The foreign scientists not only participated in discussions under various sections, but also delivered popular lectures on topics of absorbing interest like, *Viking mission and the search of life beyond earth* by Dr. Cyril Ponnamperuma (U.S.A.), *Science and natural calamities* by Academician M. A. Lavrentev (USSR), and *The Fishery Resources of India and their ultilization* by Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Calcutta.

The Indian Science Congress Association is an organization like the British Association for the Advancement of Science and the American Association for the Advancement of Science and holds its annual session in a city or big town for the benefit of exchange of ideas and personal contact among its members, over a period of five days in the first week of January. During the period, the local organizers arrange whole day, half day and short local excursions to places of interest. Scientists, their spouses and children who accompany them try to snatch out an afternoon or a day to go out for sight-seeing. Scientists are human too, they eat, drink, need rest and recreation like any other normal human being. It is unfortunate to brand the participants of the Bhubaneswar session as 'not scientists but tourists'.

A congress is a rendezvous, where participants contribute and the success of the conference depends upon how the participants take part in it. Some articles in the *Science Reporter* may appear to me dull, and I may feel it a waste of time to read through it, because I am not interested in the subject matter. Does that mean the magazine contains trash and it is a waste of national wealth to publish the magazine? *S.R.* is a popular scientific magazine. The annual session of the Science Congress is a session of scientists. Why compare a scientific session with a magazine? What is expected of the scientists attending the annual session of the Science Congress to perform acrobatics to make it lively and amusing for those who are not interested in the scientific deliberations? I have almost regularly been attending the annual sessions of the Science Congress during the last 27 years. Some critics have branded the sessions as a 'Vigyan mela', 'Dusserah of scientists', 'Graveyard of science', etc. I have found the sessions very educative.

In the last congress, the national policy on science was discussed. What else could have been done? Certainly, the organizers of the 65th Science Congress at Ahmedabad, 1978 will deeply appreciate to have constructive, realistic and operational suggestions as to how it can be made more lively and useful to the common man. Indian Science Congress Association is an association of scientists and for those who have aptitude and love for it, and not for those who do not find interest in the deliberations.

B. K. Behura
Professor of Zoology
Utkal University, Vani Vihar
Bhubaneswar-751004 (Orissa)

Particle physics

Sir, History of particle physics by Dr. V. Mukherji (*S.R.* April, 1977) should be an eye opener to the academicians of our country. That the article has had a style of its own by presenting the world of particle physics in a lucid manner is, however, not the reason. There is an inherent message in it. In our colleges and universities we spend a lot of time learning how a certain theory was conceived of and how certain experiments proceeded from its crude stage to the ultimate stage of perfection. For example, starting with corpuscular as well as wave theory of light we struggle through the school and college days and ultimately learn at the university stage that the two aspects are complementary, two manifestations of the same effect.

In this way, we spend more time in swallowing the history of science rather than science itself. History of science is equally enchanting as has been proved by Dr. Mukherji's article. Our academicians should think deeply about introducing it as a subject in our educational institutions.

B. K. SARMA
Asstt. Geophysicist
Electrological Section
ONGC, Ankleswar-393010
Gujarat

Weed menace in India

Sir, Here is a clarification regarding the letter of Mr. K. L. Mahadevappa (*S.R.*, May 1977).

Teleonemia scrupulosa or lantana lace bug was first introduced in India by Dr. Beeson of F.R.I., Dehra Dun in 1941. It was found that the insect damaged teak also. Therefore, FRI destroyed the initial stock in 1943. Later, in 1951 there was an accidental appearance of a single *Teleonemia* in F.R.I. Since then, it has spread in wide areas. F.R.I. had also sent consignments of this bug to South India and East India.

I have corresponded with the Forest Entomologist, F.R.I. who is of the opinion that the insect found by Mr. Chandrasekhar Luhumi is the same insect (*Teleonemia scrupulosa*) as introduced at F.R.I. The Forest Entomologist is of the opinion that the insect is specific to lantana. Although it is a sap sucker causing defoliation, it is not capable of killing the lantana bushes. Hence, two more exotic lantana insects namely, *Octotoma scabriennis* and *Uroplata girardi* have been introduced at F.R.I. These are leaf miners and are specific to lantana. They have been released in the field also.

V. BHASKAR
Asstt. Professor of Farm Forestry
University of Agricultural Sciences,
Bangalore, India.

Phobos and Deimos

Sir, The article **Moons of Mars** by Dilip M. Salwi (*S.R.*, July 1977) was topical and informative, like his other articles in *S.R.* and elsewhere. The author has stated that the moons of Mars, Phobos (Fear) and Deimos (Panic), have been attributed these names for unknown reasons. Actually they have been thus named purposely, for are not fear and panic suitable companions to the God of War (Mars)?

Phobos and Deimos have been mentioned as the charioteer sons of Ares (Mars) according to the Greek mythology. The Romans consider them to be the chariot horses of Mars, driven by a demented woman.

The orbital period of Phobos is given as 7.7 hrs, which, as a matter of fact, is less than the rotation period of Mars. Phobos is the only satellite known in the solar system which revolves in a shorter interval than the rotation period of its primary. The sixth satellite of Uranus, the discovery of which was reported recently by J. C. Bhattacharyya and S. Kuppuswamy, may share this honour, but even then it will come only as a second best. No wonder, at one time Phobos was considered to have been launched by intelligent Martians.

The orbit of Phobos is unique, because of its closeness to the planet and is just outside the Roche's limit. If it were inside the limit, the gravitational force of Mars would have torn Phobos asunder.

Regarding composition of Phobos, Prof. J. Veverka of Cornell University reported early this year that it was of carbonaceous chondrite. On 16th Feb., 1977 in a lecture at National Physical Laboratory, New Delhi Prof. W.H. Pickering of California Institute of Technology and ex-Director, Jet Propulsion Laboratory remarked that its composition was essentially of iron. "If we could bring it (Phobos) to earth it will keep us in business for a couple of years," he had remarked jocularly.

S. K. GURTU
Defence Science Lab.
Metcalfe House
Delhi 110054

About linear programming

Sir, In **About linear programming** (*S.R.*, July 1977) Mr. R. Ramaswamy has shown how a simple two variable problem can be solved by using linear programming. The general linear programming problem can be written as:

$$\text{Minimize or maximize} \quad f=\sum_{j=1}^{n} c_j x_j$$

$$\text{Subject to} \sum_{j=1}^{n} a_{ij}x_j > b_i, \quad i=1,2......m$$

$$\text{and} \quad x_j > 0, \; j=1,2......n$$

This cannot be solved by using the graphical method. If the constraints are 'greater than' or 'less than', we have to subtract or add a variable which is called a 'slack' variable. We may also have to introduce artificial variables if the formulation is not in the canonical form. One more advantage of linear programming is its duality.

Linear programming applications span a remarkable variety of subjects, from agriculture to economics, from petroleum refining to engineering. T. C. Koopmans in the U.S.A. and L.V. Kantorovich in the U.S.S.R. have applied linear programming to economics for which they were jointly awarded Nobel Prize for economics in 1975. Readymade computer programs are available in all computer centres and solutions can be obtained in minutes.

N. SUBRAMANIAN
Senior Research Fellow (CSIR)
Department of Civil Engineering
Indian Institute of Technology
Madras-600036

Prostacyclin

Sir, I read **Significance of prostaglandins** by Dr. U. N. Das (*S.R.*, July 1977) with great interest. But the article has not given even a line about the newly discovered prostaglandin known as PGI_2 or prostacyclin. The first report on prostacyclin came from Wellcome Research Laboratory of United Kingdom (*Nature*, 263, 263, 1976). S. Moncada *et al.*, while working on an enzyme system, isolated it from arteries of rabbit and pig. This unstable and new prostaglandin which is a transformation product of prostaglandin endoperoxides was named PGX by the same group of workers. Dr. U. N. Das writes in his article that PGE inhibits aggregation of platelets, but this new prostaglandin is 30 times more potent in this respect than PGE. Later, this PGX was named as PGI_2 by C. Pace-Asciak (*J. Am. Chem. Soc.*, 1976, 98, 2348).

Recently, a report from Netherlands appeared in *Nature* (vol. 268, pages 160-163), by E. A. M. De Deckere *et al.* about release of prostacyclin from the isolated perfused rabbit and rat heart. Prostacyclin is formed by microsomes from several organs such as pig and rabbit aorta, rat stomach and by fresh human arterial and venous tissues when incubated with PGH_2 as described by S. Moncada *et al.* (*Lancet*, 1977, i, 18-22). PGI_2 helps in pre-

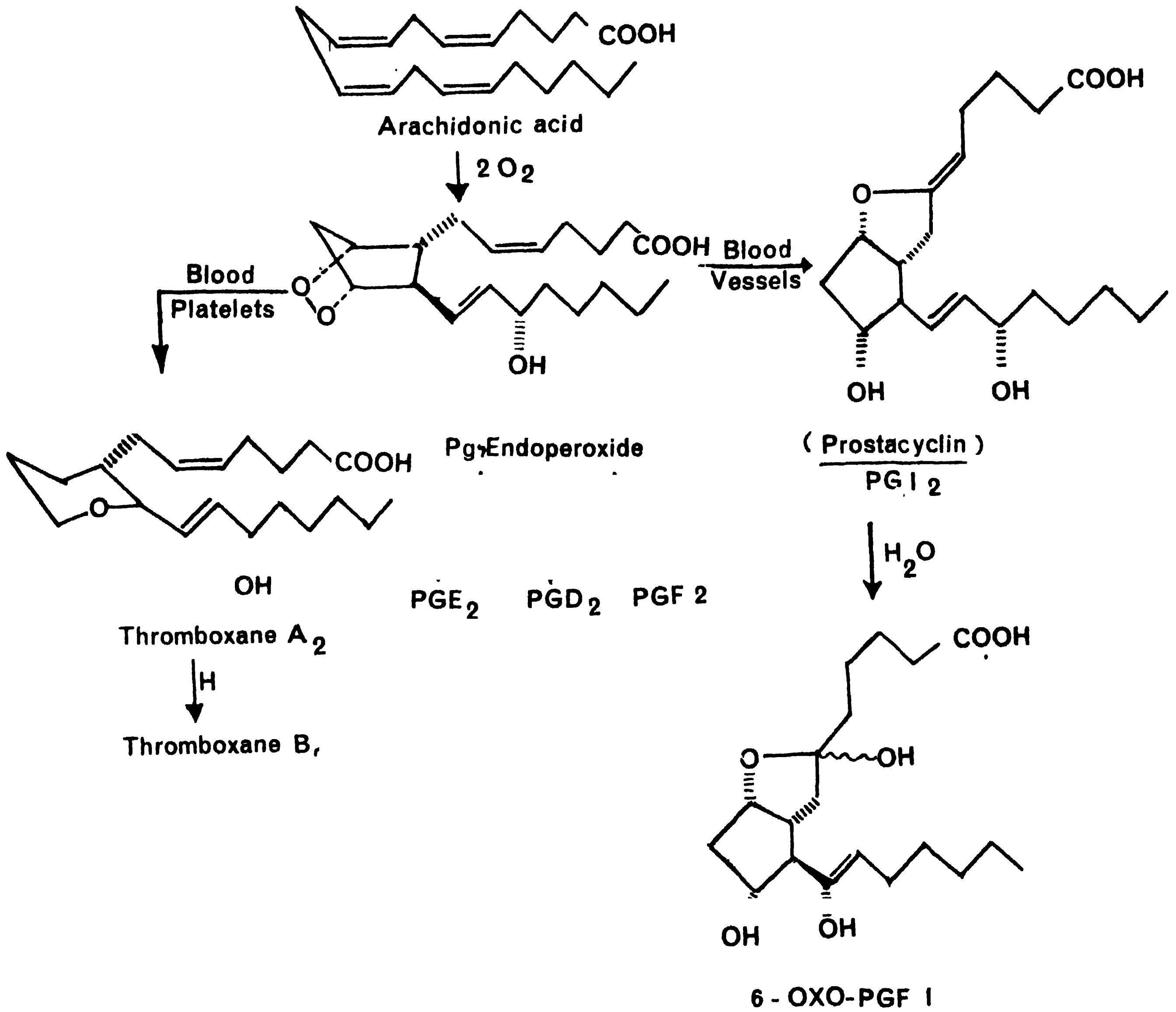


Fig Formation of prostacycline, PGI_2

venting the formation of intra-arterial thrombi. Prostacyclin is chemically unstable in aqueous media and is rapidly hydrolyzed to 6-oxo-PGF$_1$ (Fig. 1), which does not inhibit blood platelet aggregation. Considerable amount of this substance, 6-oxo-PGF$_1$ in the perfusates suggested that prostacyclin is the major prostaglandin released from the heart.

The production of prostacyclin from heart and its anti-aggregating property, according to De Deckere, indicates that the main function of this prostaglandin is to protect coronary circulation against the formation of platelet aggregation and thus prevent the occlusion of small branches of the vulnerable coronary tree. If the results worked out by these workers are extrapolated to human heart, prostacyclin could be a key substance in prevention of coronary diseases.

RAI AJIT KR. SRIVASTAVA
Biochemistry Deptt.
RRL, Jorhat-6 (Assam)

Allergy

Sir, I have been reading with great interest various articles in the field of medical science and biochemistry published in your journal from time to time. I am interested in the latest research findings in the field of allergies—especially the intermediary toxic substances produced during antigen-antibody reaction. Of late, there has been a controversy over the type of certain toxic substances like histamine, serotonin and bradykinin produced in different sensitive organs of a patient. While the popular belief is that histamine is produced in the lungs as a result of the antigen-antibody reaction, some workers feel that a substance other than histamine is produced in the lungs which renders antihistaminics against asthma ineffective, though for nasal allergy these agents work better.

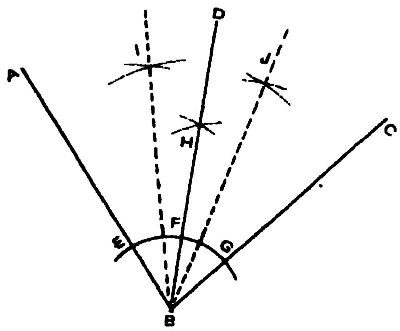
Can any of your readers elucidate this point and inform precisely what type of chemical is produced in the lungs as a result of the above reaction, which triggers off the spasm in bronchial asthma?

MANOHAR T. SANTWANI
Deputy Director
Indian Standards Institution
New Delhi-110002

Can you trisect an angle?

Sir, Trisecting an angle is a problem which still baffles a geometrician. I have found the following method of trisecting an angle.

Take any angle ABC, whether acute or right-angle or obstuse, and draw its bisector BD. Taking B as centre, draw a suitable arc to cut the angle arms and the bisector at E, G, and F respectively. Now taking F as centre, again draw the same arc to cut BD at H; and then taking H as centre draw a circle, the radius being the same as before.



Now taking points E and G as centres draw arcs of radius twice the radius of the above arcs. In other words, the radius of the arcs should now be 2BF or BH. The arcs would cut at I and J. Join IB and JB. The lines IB and JB trisect the angle ABC.

B. VIJAYAN
T.K.M.M. College
Nangiarkulangara, Kerala

Civil engineering

Sir, I am thankful to you for the article **Sedimentation in Indian reservoirs** (*S.R.* June 1977). The article is of absorbing interest to students of civil and agricultural engineering. We request you to publish more articles on subjects of civil engineering (such as failure of bridges, dams. etc.) which will interest us to take up research studies on these topics.

G. KONDALA RAO
4/5, B. Tech. (Civil)
College of Engg.
Kakinada (A.P.)

Emulsions

Sir, I read *S.R.* regularly with great interest. It is very useful for science students. I think there is immense importance of applications of emulsions in our daily life. I would request you to publish an article on "Emulsions, its importance and applications".

LOKNATH GHOSH
Research Worker
Department of Food Technology
& Biochemical Engineering
Jadavpur University
Calcutta-700032

Crocodile skin

Sir, I would like to know the names of crocodiles whose skins (*S.R.*, April 1977) are very expensive. Also, how the price of a skin is determined. How do you kill the animal?

A. ESWAR
R.B.S. College, Bichpuri
Agra-5

There are three types of Indian crocodiles : (1) *Gavialis gangeticus*, the long snouted fresh water crocodile; (2) *Crocodylus porosus*, the short snouted salt water or estuarine or marsh crocodile; and (3) *C. palustris*, the short snouted mugger or fresh water crocodile.

The skin of the salt water crocodile, *C. porosus* is highly expensive because it has smaller scales on its body, whereas the mugger, *C. palustris*, has large scales on the belly and so its skin is less expensive. The gharial is a medium scaled crocodile.

Generally, crocodiles are killed by a sharp weapon or by axe or by shooting. Poachers usually kill by shooting and hooking. Hooks, fixed to a chain, are placed on the favoured basking site. When the crocodile comes out to bask, it is hooked.

Due to high prices of crocodile skins in European markets (one sq. inch of the crocodile skin fetches about Rs. 40/- in Europe), crocodiles are fast depleting.

MADIREDDI V. SUBBA RAO
Post-Graduate Deptt. of Zoology
Utkal University
Bhubaneswar, Orissa-751004

Amoebic dysentery

Sir, I would like to point out an inaccurate statement in the article of Sohail Ahmed on **Amoebic dysentery—a serious health problem** (*S.R.*, March 1977). He mentioned that "chlorination of water and washing the vegetables with chlorine solution are quite effective in preventing an infection". On the contrary, the following statement is worth noting: "A water system that provides standard chlorination and piped delivery will not ordinarily be safe as regards amoebiasis without effective filtration, since water can carry amoebic cysts. Hyperchlorination is required to kill amoebic cysts, and this is unacceptable on two counts: high cost and objectionable flavour. Filtration is therefore essential whenever chlorination is required" (*Technical Report Series No. 421 on Amoebiasis* published by WHO in 1969).

Regarding the treatment, an oversimplified statement has been made. There are drugs, no doubt, but their efficacy principally depends on the site of the infection.

DEVABRATA SETH
Deptt. of Parasitology
Sarabhai Research Centre
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Eucalyptus

Sir, I read the article **Advantages of eucalyptus growing** (*S.R.*, Feb. 1977, p. 112). I would like to draw the attention of the author that, in spite of the advantages of growing *Eucalyptus* in our country, this genus has a serious disadvantage. *Eucalyptus* is a phreatophyte, and consumes water from permanent water table. Owing to its higher consumption of water, groundwater is depleted, resulting in water scarcity. So, large scale plantation of this genus may be harmful in future.

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There is a widespread apprehension about the possible adverse effect of Eucalyptus plantations on the assumption that they use large quantities of water and affect local water supplies. This has its origin in the reclamation work of the Pontino marshes in Italy where *E. robusta* and *E. rostrata* were extensively planted. The capacity of these two species to grow under swampy and waterlogged conditions are characteristic features of these species which cannot be attributed to all other species numbering over 3000. The species vary—some capable of growing in semi-waterlogged conditions and others in very arid areas. In Australia, species like *E. brockwayi*, *E. salubris*, *E. salmonophloia*, *E. siderozylon* and *E. transcontinentalis*, grow naturally in areas having mean annual rainfall of 200-640 mm. If all these species were so extravagant about water, they would have ceased to exist in these areas which by now would have turned into desert.

In India, Eucalyptuses have been tried for raising large scale plantations in the country as they have almost all the desired qualities of wood required for both domestic and commercial purposes. In Punjab, Haryana, and U.P., where *Eucalyptus tereticornis* is being grown along the roadsides, canal banks or on the field bunds, high yielding wheat crops are being grown under intensive irrigation. Perhaps use of water by the agricultural crops is one of the main reasons for the depletion of ground water resources in such areas.

It has been observed that evergreen ground vegetation thrives under Eucalyptus plantations, which indicates that the plantations have profound influence on soil-moisture conservation. Investigations carried out both in India and Israel have shown that loss of rainfall due to interception is lower (less than half) in Eucalyptus as compared to other broad-leafed species such as sal, teak, khair, etc.

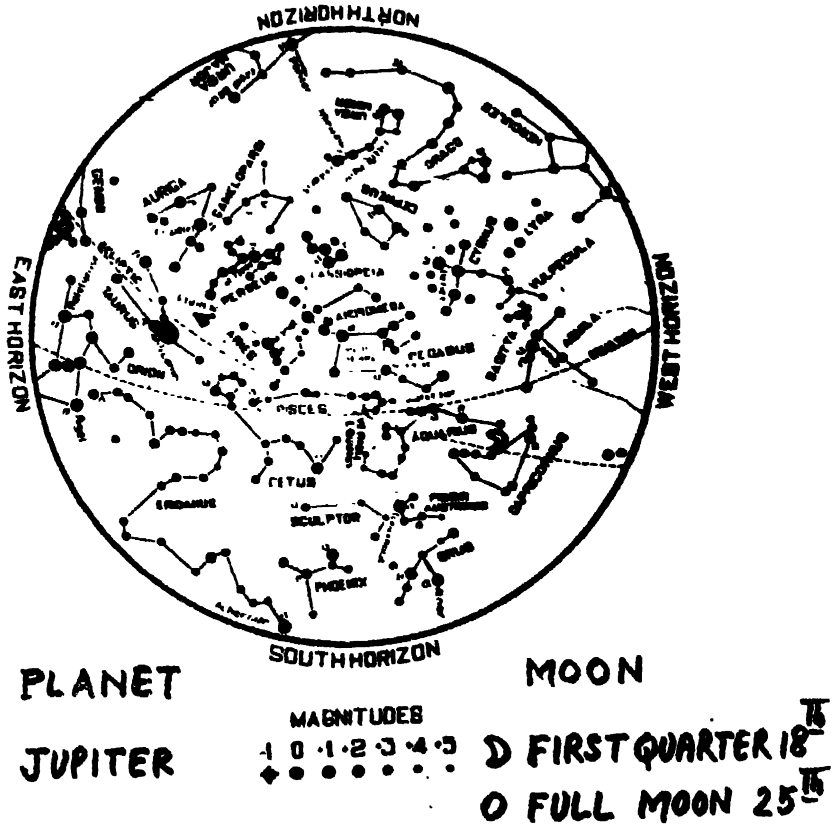
Studies on the annual transpiration rate of *E. globulus* in the Nilgiris have shown that out of 130 cm of rainfall only 35 cm get transpired. Also, Eucalyptus roots penetrate to shallower depths in comparison to others, which shows that the plants generally do not tap deep ground water reservoirs, which other deep-rooted species are very likely to do.

It has been experimentally proved that water consumed per unit gm. of diameter produced was the least in *E. tereticornis*, i.e., 1.41 mm as against 2.59 for *Dalbergia lati-*

(*Continued on page 668*)

Planets and their positions

NOVEMBER 1977



The moon

NEW moon occurs on 11th at 12-39 p.m. and full moon on 25th at 11-01 p.m. I.S.T.

The moon passes about five degrees south of Jupiter on 1st, about seven degrees south of Mars on 3rd, five degrees south of Saturn on 5th, is very close to Venus on the 10th, is about six degrees north of Mercury on 12th and again about four and a half degrees south of Jupiter on 28th.

The lunar crescent becomes first visible after the new moon day in the evening of 12th.

The moon is at perigee or nearest to the earth on 12th and at apogee or farthest from it on 28th.

An occultation of the planet Venus by the moon will occur in the early hours of 10th. It will be visible in strong twilight at Madras from 5-29 a.m. on the eastern horizon. The sun rises at Madras at 6-05 a.m. before the time of emersion.

The planets

Mercury (Budha) is too near the sun to be visible during the first half of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes three degrees north of the star Antares (*Jyestha*) shortly after midnight of 15th. It moves from Libra (*Tula*) to Sagittarius (*Dhanus*) through Scorpio (*Vrischika*). Its visual magnitude is about—0.3.

Venus (Sukra), a morning star, rises about an hour before sunrise during the month. It passes four degrees North of the star Spica (*Citra*) in the very early hours of 4th. It moves from Virgo (*Kanya*) to Scorpio (*Vrischika*) through Libra (*Tula*). Its visual magnitude is about—3.4.

Mars (Mangala), visible in the morning sky, rises about one and a half hours before local midnight during first half of the month and about two and a half hours before it during the second half. It is in Cancer (*Karkata*). Its visual magnitude varies from +0.4 to—0.2.

Jupiter (Brihaspati) rises about three and a half hours after sunset during the first half of the month and two and a half hours after it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about - 2.2.

Saturn (Sani), visible in the morning sky, rises at about local midnight during the month. It is in quadrature with sun on 22nd. It passes very close to the star Regulus (*Magha*) in the evening of 3rd. It is in Leo (*Simha*). Its visual magnitude is about +0.8.

(*Source*: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st floor), New Alipore, Calcutta-53).

THE ORIGIN OF LIFE : Chance or Necessity ?

The beginning of life may have been a chance event, but thereafter its progress along the evolutionary ladder all the way to man was an uninterrupted, continuous process

JAGJIT SINGH

IT is curious that despite the antiquity of life our knowledge about its origin, fragmentary as it is still, is so recent. The earlier ages had, no doubt, their theories. But their authors, totally ignorant of the complexity of the problem, had naive ideas as to how life actually arose on earth. As usual, the greater the ignorance, the more pompous the verbiage devised to mask it. *Generatio acquivoca, generates primaria* expressed the belief that fully formed living organisms arise miraculously out of non-living matter. Since one miracle deserved another, life's miracle on earth could be repeated with equal facility and abundance everywhere. This is why some sober pioneers of stellar astronomy like Sir William Herschel felt fully authorized on 'astronomical principles' to populate even the sun with innumerable inhabitants! If there is now greater sobriety in the appraisal of the possible existence of life in the universe, it is because of our greater understanding of life and its processes. We no longer define a living being, as Woodger did some time ago, as "an *X* in addition to carbon, hydrogen, oxygen, etc., plus organizing relations". Apparently the mysterious *X*-component was thrown in because of the alleged statistical improbability of a random mixture of the aforementioned elements ever forming the basic materials of life, enzyme proteins, nucleic acids, and other specialized structures by a purely 'fortuitous concourse of atoms'.

As recently as the 1950s the biologist, Lecomte de Nöuy, had argued that if the universe is merely a medley of randomly moving molecules and if the ultimate particles like electrons and protons build up atoms, and atoms build molecules, and molecules colloidal particles, and so on, then it is practically impossible that the ultimate particles could have organized themselves by pure chance in such highly complex structures as human beings, or even living cells and protein molecules for that matter. Thus, the odds that a moderate-sized molecule consisting of, say, 2,000 atoms and possessing the same degree of asymmetry as a protein molecule should arise by random processes are roughly one in 10^{813} against it. These odds are so large that we might as well concede that the occurrence of life is a *miracle* requiring an act of special creation and thus hand over the problem to theology and metaphysics. But the argument is no better than that of a bridge player who, having been dealt with a bumper hand, cites the event as proof of providential intervention. Every hand, bumper or otherwise, has a very small chance of occurring. But if we begin to deal the cards some hand, no matter what its chance *before* the deal, has to occur. Once it has occurred we can-

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(T Singh is a well-known science writer and a recipient of UNESCO's Kalinga prize for science popularization not claim that its occurrence is due to the working of some special contrivance because of its low *before-the-deal* chance of occurrence.

The answer to de Nöuy's argument lies in showing that the basic laws governing the behaviour of matter are such as could have led to the genesis of life by a natural process rather than by the fiat of an Almighty God. To do so we have to search for and formulate the organizing principles that led to the emergence of life, such as Newton's law of gravitation making the solar system what it is, or Maxwell's equations governing electromagnetic phenomena. In the case of life's genesis from inanimate beginnings, the basic organizing principle is the chemical law of valence which itself is a consequence of the inherent structure of atoms. On the basis of these laws chemists were able to explain the great power of carbon to form a multitudinous variety of compounds which is the secret of its capacity to function as a veritable backbone of living matter. The emergence of these carbon compounds—the proteins and nucleic acids—is thus merely the self-realization of the potentialities of atomic electronic states. Nöuy's objection to a naturalist origin of life on account of its statistical improbability disregards the chemical basis of life. It tacitly assumes that *all* permutations of atoms are *equally* likely in total disregard of the fact that most permutations are excluded by the electronic structure of atoms while some others are heavily favoured. His argument therefore is of a piece with the statistical 'deduction' that since the chance of even a single meaningful sentence in Shakespeare's works arising by a random strumming on a typewriter is infinitesimal, no such work could ever arise! The fallacy lies in ignoring the mechanism responsible for stringing letters of the alphabet in one case and atoms in the other. If we pay due regard to the chemical proclivities of atoms built into their electronic structure and treat the question of origin of life as a problem of chemical kinetics and thermodynamics, we find that emergence of life, far from being a highly improbable event, is all but inevitable, given the right conditions.

A. B. Zahlank has shown how life could arise as a result of random and purely chemical events. Taking catalysis as the main agent and using information theory and topology, he arrives at a set of systems with about six catalysts per system which could lead to the emergence of a sequence of chemical reactions involving replication, performed on metabolites supplied by the environment. Although such schemes are purely formal, they do expose the error in denying a natural origin of life on the grounds of its statistical improbability. But Jaques Monod in his best-seller, *Chance and Necessity*, gave new verisimilitude, if not actual proof, to the natural origin theory. He showed, with a wealth of chemical knowledge seasoned with immense literary erudition, that once a few self-replicating macromolecules of nucleic acids, we now call genes, arise, there is no stopping of evolution of life from this self-replicating macromolecule all the way to man as an increasingly complex crescendo of self-sustained patterns of chemical reactions.

The crucial property of this macromolecule, or 'seed of life', is what he calls *reproductive invariance*. By this he means the capacity of a highly ordered structure like a gene to reproduce itself. Since a structure's degree of order can be defined in units of information like that of a computer programme in 'bits', we can say that the invariant content of an organism, no matter how primitive or how complex, "is equal to the amount of information which, transmitted from one generation to the next, assures the preservation of the specific structural standard." Now this property of reproductive invariance, that is, reproduction without gain or loss of information required to build it, incorporated in the genetic structure we nowadays call DNA, may be the outcome of chance. For it is "essentially unpredictable". But once arisen, it will enable the macromolecule to mechanically and faithfully replicate itself almost *ad infinitum*. The upshot then is its explosive growth into millions and billions of copies. We see this explosive growth continually at work in all organisms from cultures of lowly bacilli to human populations. Thus the parental macromolecule may be the outcome of chance but not its subsequent multiplication. As Monod says, "Drawn out of the realm of pure chance, the accident enters into that of necessity, of the most implacable certainties".

If I may abbreviate Monod's argument in *Chance and Necessity* in the form of an allegory, it is as follows: Your chance of winning a lottery may be infinitesimal. But if it is not zero, that is, otherwise impossible, you are bound to win some time or other, provided you have quasi-infinite time and equally ample resource to continue the game. Further, once you have made your first million in a lottery, its subsequent multiplication into more millions and billions is no problem. They come almost automatically and all but effortlessly! Likewise, the first self-replicating macromolecule of life—the analogue of the first million—may arise by chance and the chance may well be very small. But given four billion years of earth's existence and its environmental resources, even a small chance will produce macromolecules endowed with the property of reproductive invariance. As Monod says, "Even today a good many distinguished minds seem unable to accept, or even to understand, that from a source of noise natural selection, alone and unaided, could

Did life originate in space?

DID life originate in the interstellar space—in the cosmic dust clouds? Such a possibility was first conceived almost a hundred years ago by the famous Swedish chemist S. Arrhenius and others. Variously known as the theory of Cosmozoa or Panspermia, the concept postulated the transfer of small particles including spores of microorganisms through interstellar and interplanetary space. But later such an idea seemed improbable and was soon forgotten. The primordial seas and oceans of our planet were considered an ideal cradle for the origin of life. A.I. Oparin's (USSR) thesis and Stanley Miller's (U.S.A.) historic experiments with simulated primitive terrestrial atmosphere gave credence to the chemical evolution theory. But they could not go far in explaining the coming into being of the first living cell.

Of late, the spotlight has again turned on the extraterrestrial origin theory, this time with the British astrophysicist Fred Hoyle as its chief proponent. Hoyle and his associate N. Chandra Wickramasinghe base their arguments on the discovery of complex organic molecules in space. Over the past decade, radio-astronomical observation of prestellar clouds have shown the existence of a rich variety of organic molecules. More than 40 of them have been identified so far including the polysaccharide, cellulose (*see page* 641).

Hoyle and Wickramasinghe believe that prebiotic biological systems could have evolved from such molecules under interstellar conditions and carried to earth by cometary dust, meteoroids and meteoritic particles. A strong evidence of possible link between interstellar dust, meteorites and the transport of life to earth comes from recent spectroscopic studies of extracts of organic materials from meteorites. Some earlier reports even claimed identification of microfossils in meteorite fragments. In a recent experiment the infrared spectra of insoluble organic material from meteorite was found to be identical with those of pollen-like spores in Pre-Cambrian sediments on earth. May be, these spore-like primitive interstellar 'protocells' were the precursor of all life on our 'living' planet.

B. B.

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have drawn all the music of the biosphere. In effect, natural selection operates *upon* the products of chance and can feed nowhere else; but it operates in a domain of very demanding conditions, and from this domain chance is barred. It is not chance but to these conditions that evolution owes its generally progressive course, its successive conquests, and the impression it gives of a smooth and steady unfolding".

Although the main thrust of Monod's argument seems incontrovertible, it has recently been challenged by another of his countrymen, E. Schoffeniels. In his book *Anti-Chance*, Schoffeniels claims to subvert Monod's arguments completely. In fact, the subtitle of the book itself is called "A Reply to Monod's Chance and Necessity" to highlight its basic theme. He is provoked to make the "reply" because in his opinion Monod's thesis of biological evolution is based on obsolete biological ideas inherited by him from nineteenth century biologists like Darwin and Lamarck. As he says, Monod's book "is a very elegant tableau of nineteenth century biology seasoned with several piquant spices which ornament the biochemists' shelves. And this is a pity because, with a brilliant past as a researcher, who better accredited in France than Monod can present a truly modern view of biology with its realities and hopes?

"On the contrary, in a vigorous well-muscled and minutely detailed style, the author proposes certitude which appease the anguish of our contemporaries....... Monod's book is deceiving because it leaves the reader eager. With an eloquent style which borders on the pathetic and which certainly would not be abjured by our great romantics, the argument unfolds according to an extremely simple logic. The concepts of chance and necessity, central themes of the work, are always far from adequately analyzed. And it is here that confusion and ambiguity arise. One comes away from reading the work frustrated since one knows not whether, in the mind of Jaques Monod, life is the result of coincidence of diverse independent chains of causality or, on the contrary, whether it obeys the more fundamental concepts of chance as proposed by the Danish school of physicists. Lastly, problems of evolution and finality in biology are juggled in consoling reference to largely diffuse and yet quite debatable ideas formulated since the beginning of this century".

I had read Monod's *Chance and Necessity* when it was first published several years ago. On reading Schoffeniels *Reply to Monod* I re-read Monod's book to see if Schoffeniel's critique has any validity. Unfortunately for him, I still prefer to remain a "great romantic" with Monod rather than a dull and pedestrian "realist" with Schoffeniels. It is not Monod's book that is "deceiving" but rather Schoffeniel's reply. If Monod's book invokes chance to explain the transformation of species by the interplay of mutation and natural selection, this cannot be regarded as its demerit simply be-

(*Continued on page 658*)

BEFORE YOU MARRY GO TO A GENETIC COUNCELLOR

There are more than 2000 known genetic disorders of man. Many of them can be prevented by proper genetic councelling

P. K. SETH

S. SETH

THE phenomenal increase in our knowledge of the basis of genetic diseases and the development of reliable diagnostic methods during the past 50 years, especially in the developed countries, has seen a steady decline in infant mortality from these diseases. However, this rapid expansion in our knowledge about genetic diseases has not been accompanied by concomitant development in transmission of this information to the affected families. Today, almost 2000 genetic disorders are known, some are harmless, while many others are severely handicapping and result in physical, emotional and financial burdens on individuals, their families and society. There are many disorders not based on simple genetic mechanisms, but are significantly more frequent amongst the close relatives of affected persons than in the general population. Large scale surveys enable empirical risk figures to be established, so that families can be given suitable advice. When this advice relates to the possibility of a particular genetic disorder in future children and other family members, it is known as 'Genetic counselling'.

Genetic counselling is the most immediate and practical service that genetics—the science of hereditary transmission of traits from parents to their offsprings—can render in medicine and surgery. Despite an increase in our knowledge of the genetic code, much of genetic counselling is still concerned with statistical risk estimates of having an abnormal child. Recent advances in medicine and genetics, like antenatal diagnosis by means of amniocentesis, help the genetic counsellor in giving the parents exact information as to the status of their unborn child in regard to any genetic disorders. Genetic counselling is best done by individuals trained especially in chromosomal and biochemical genetics. It allows prenatal and early postnatal detection of affected individuals and of carriers of defective genes. Early identification allows appropriate therapeutic measures, thus minimizing later pathological conditions.

The conception of a child within the mother's womb takes place when a sperm from man—containing 23 chromosomes—unites with the ovum from woman which too contains 23 chromosomes. But if a sperm with a chromosome complement other than 23 (22 or 24) unites

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Dr. Seth is principal investigator, Genetics of Mental Retardation, Deptt. of Anthropology, Delhi Uni.,; Smt. Seth is co-investigator in the same project with an ovum with 23 chromosomes, the resulting zygote will develop into an abnormal child. Likewise, if a sperm with 23 chromosomes unites with an ovum containing a haploid set of chromosomes other than 23, then also it would result in a zygote leading to an abnormal child. Normally, any deviation in the process of fertilization of an ovum leads to the development of an abnormal fetus resulting in spontaneous abortion or still-birth. But if the child is born alive, it would be abnormal.

Pregnancy in women above the age of 30 years often results in the birth of a mongol child (Table 1). Another condition often found with children of mothers above 30 is 'Trisomy 21.' Increase in maternal age possibly leads to failure of a pair of chromosomes to separate during division of the sex cell (oocytes). The age of the father, however, has no such implications. The reason for this is that the spermatozoa are produced in a male throughout his life, whereas oocytes are produced in a female quite early in life and then remain in the ovary till about 50 years of age. Mothers beyond 30 years of age, therefore, must seek genetic counselling before going in for more children, especially if they had an abnormal child earlier.

Table 1

Maternal age	Risk of occurrence of birth of a 'mongol'	Risk of recurrence of birth of a 'mongol'
20—30	1 : 1500	1 : 500
30—35	1 : 750	1 : 250
35—40	1 : 600	1 : 200
40—45	1 : 300	1 : 100
45 upwards	1 : 60	1 : 20

Table 2. Rh compatability (—) and incompatability (+) combinations between parents and the baby

Father	Mother	Fetus/baby	Rh haemolytic disease
Rh –	Rh –	Rh –	–
Rh –	Rh +	Rh – or Rh +	–
Rh +	Rh +	Rh – or Rh +	–
Rh +	Rh –	Rh +	+
Rh +	Rh –	Rh –	–

Genetic counselling can enable parents to avoid the risk of having a deformed child. For example, if prenatal examinations reveal a genetically damaged or deformed fetus, the parents may then decide to terminate the pregnancy. If the tests give normal results, the parents could then look forward to the birth of a healthy child. Of course, for complete success of the method, continued but carefully controlled studies of the precise risks to the mother and the fetus are essential.

The possibility of giving useful genetic advice has increased in recent years as techniques for rapid, safe and accurate diagnosis of genetic defects are being integrated into the practice of medicine, almost as rapidly as they are being developed. In this progress, biochemical and cytogenetical advances have played an extremely important role. As many of the biochemical disorders have a common clinical, phenotypic intellectual impairment (similar morphological and behavioural symptoms), simple and practical methods utilising microorganisms have been developed for mass screening. Bacterial inhibition assays are widely used in the screening programs for the detection of amino acid disorders.

There is general agreement that screening for genetic disorders like phenylketonuria, galactosaemia and fructosaemia among new born infants is beneficial because early detection and treatment contribute significantly to the health and well-being of the children with these disorders.

Of the genetic diseases that can be detected in newborn screening surveys using dried blood specimens, phenylketonuria, homocystinuria and histidinemia are not associated with symptoms appearing early in life. On the other hand, Maple syrup urine disease, hereditary tyrosinemia and galactosaemia are life threatening conditions with symptoms appearing early in life.

Erythroblastosis foetalis, a disease called hemolytic anemia of the fetus or a newborn infant (commonly known as +ve or —ve blood or rhesus factor), occurs when Rh-antibodies present in the mother's circulation cross the placental barrier and damage the foetal red cells by agglutination (clumping together) of the erythrocytes (red blood corpuscles). This Rh-haemolytic disease can be controlled by treating the affected infant. But recent advances in immunology have provided means of effective prevention.

The entry of foetal red cells into the maternal circulation occurs during labour and placental separation. Most sensitisation, i.e., production of Rh antibodies, therefore, occurs about that time. That is why the Rh +ve child is usually unaffected. It has also been noted that if the Rh+ve fetus has an ABO blood group incompatible with that of the mother, the likelihood of Rh immunization occurring is much diminished. This could possibly be due to naturally occurring anti-A or anti-B in the maternal plasma which destroys the foetal red cells of the appropriate blood group.

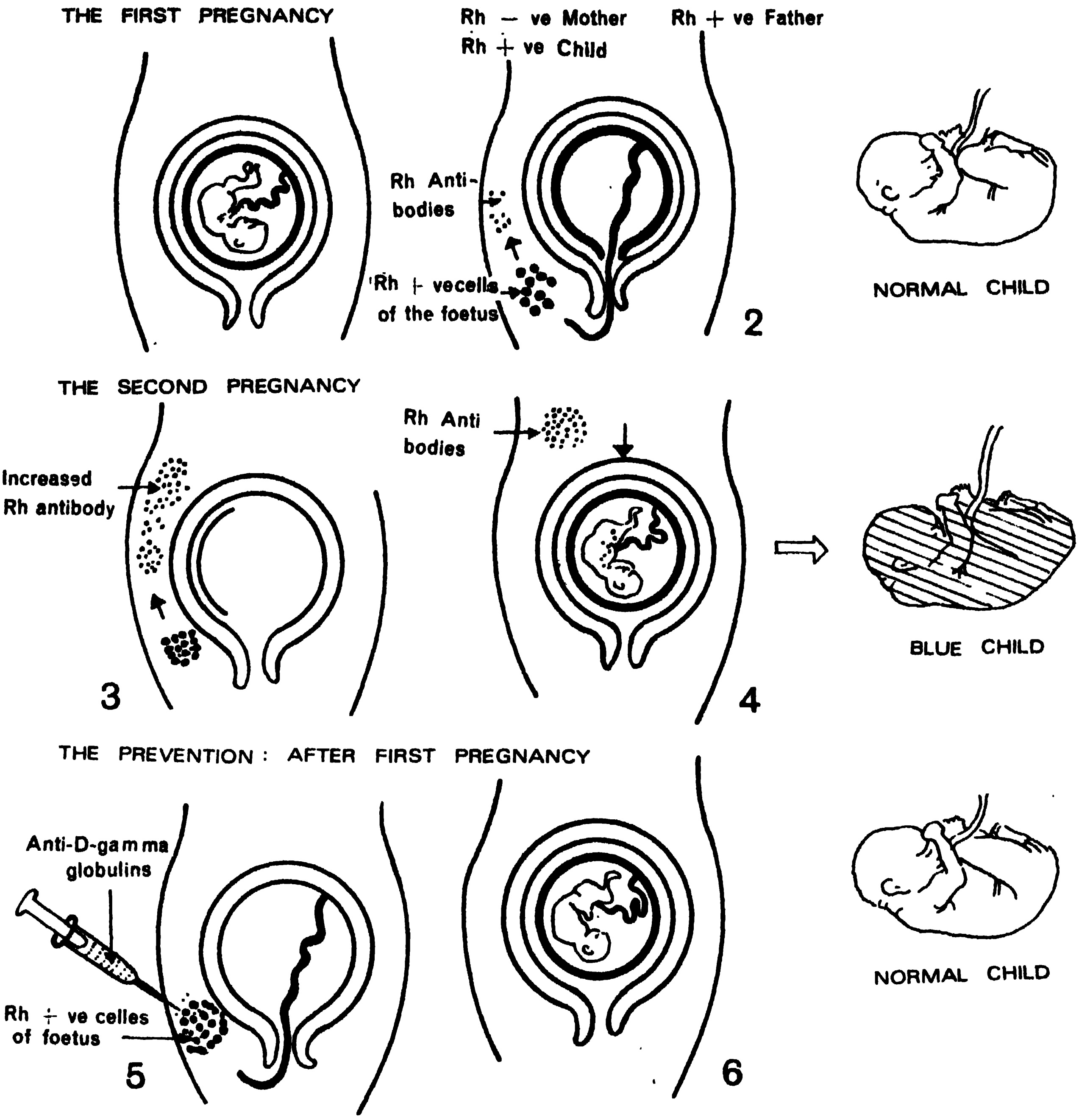


Fig. 1. Cause and prevention of erythroblastosis foetalis. Placenta is expelled at birth of an infant and the Rh + ve fetal cells leak into the maternal circulation and produce Rh antibodies (2). Rh + ve cells disappear from the mother's circulation but the Rh antibodies remain for many years (3). All future Rh + ve babies will be affected (4). Intramuscular injection of anti-O gamma globulin (Rh antibodies) within 72 hours of delivery eliminate Rh + ve fetal red cells from the mother's circulation (5) thereby suppressing immunisation (sensitisation) (6) and birth of a healthy child

Genetic counselling has rapidly changed from a simple presentation of a Mendelian probability to the identification of high risk marriages. More recently identification techniques, such as fluorescence (emmission of radiation as a result of exposure to UV light using different dyes) and heat treatment (technique for producing banded segments along the chromosomes to facilitate their identification), have enabled genetics to elicit considerably more data from chromosomal examination. Some of these disorders, which are incompatible with embryonic or foetal survival, cause intrauterine death of the infant. Thus, a large number of spontaneous abortions are the result of chromosomal anomalies incompatible with extra-

Table 3. Combinations of ABO blood groups which do not afford protection against Rh hemolysis

Mother's blood group	Foetal blood group
O	O
A	O or A
B	O or B
AB*	A, B or AB

*An AB mother cannot have a baby of blood group O

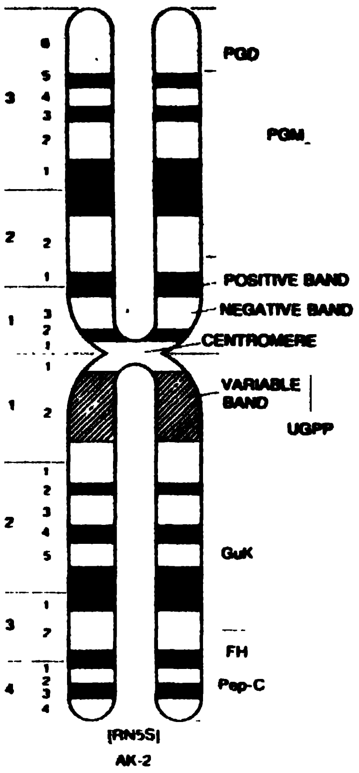
uterine existence. If survival is possible, the child is born abnormal. Sometimes, the child is of normal appearance at birth and the pathological condition does not become evident until later, or may even be delayed until puberty as is the case with certain sex chromosome anomalies. For example, in a woman with one sex chromosome (X) missing, i.e., having a chromosomal formula 45X (monosomy of X-chromosome), the condition is known as Turner's syndrome. Treatment of this chromosomal abnormality characterised by ovarian dysgenesis (degeneration of ovaries), primary amenorrhea (a condition in which onset of menstruation is delayed beyond 17 years), mental retardation, etc., with oestrogens enables menstrual cycle to be induced and there is some limited mammary development.

Other chromosomal disorders have a more localised action and lead to the malformation of certain visceral organs. For example, all 'Trisomy-18' individuals and almost half the number of cases of 'Trisomy 21' suffer not only from heart defects but have facial deformities, mental and motor retardations etc.

Although these chromosomal disorders are not amenable to treatment, their detection in a family helps the genetic counsellor to estimate the risk of recurrence of the abnormality in future children. Parents thus informed can plan their families accordingly. If the parents decide to have another child, fully aware of the risks involved, they can prepare for the proper medical and social care, if needed.

Genetic counselling is not concerned solely with risk facts and figures, but also provides an explanation of the cause of the disease.

In India, where superstitions still exist among the people, a belief exists among them that still-birth, abortion, onset of a disease, malformed child, mental retardation, physical disabilities, etc., are due to the sins of the wife, or the husband, or is the curse of God. Guilt must be dispelled by the genetic counsellor and recrimination dissipated between spouses, and sometimes with in-laws. While genetic counselling has made significant progress in other countries, we do not find its impact in India. This is mainly due to the absence of awareness among the people about the utility of genetic counselling. The systematic enumeration of the probable genetic consequences



Human chromosome number one, the best mapped for genes up to date. Genes are designated by the initials of protein products they code for

Tay-Sachs disease

FOR about six months, the new born grows into a happy. healthy and bright infant. And, then, a trouble starts : Physical and mental deterioration sets in until the loss is total. What is the disease? The doctor diagnoses it as Tay-Sachs.

Tay-Sachs is an inheritable disease caused by the lack of a gene-coded enzyme that normally controls harmful accumulation of fat around cells of the nervous system. The absence of the enzyme is, however, inevitable when a child inherits from each parent a recessive gene which permits fat accumulation. The enzyme that prevents against fat deposition was discovered by Dr. John O. Brien of the University of California, San Diego. He also discovered a means to detect the carrier of genes for Tay-Sachs. Though Tay-Sachs is most common among persons of eastern European Jewish heritage, the disease is present in other races too.

Since parents carrying a recessive gene for Tay-Sachs are more likely to produce a disease afflicted child, genetic counselling and timely testing of amniotic fluid surrounding the fetus can help detect such a defect. In case the tests are positive one should, logically, prefer abortion to a malformed baby !

Z.I.

Table 4. Some chromosomal abnormalities and associated features

Chromosomal anomaly	Associated symptoms/features
Cri-du-Chat syndrome (deletion of a part of small arm of chromosome 5)	Faint mewing cry resembling that of a kitten, round moon face, microcephaly, hypertelorims, low birth weight, cardiovascular anomalies.
Patau's Syndrome (trisomy of chromosome 13)	Mental subnormality, microcephaly, hypertelorism, low birth weight, polydactyly, hairlip and cleft palate, small mandible (lower jaw), low set ears, ventricular septum defect of the heart.
Edward's Syndrome (trisomy of chromosome 18)	Dolich-ocephaly (long headed), hypertelorism, low set deformed ears, micrognathia and retrognathia, camptodactyly, rocker bottom foot, low birth weight, ventricular septum defect of the heart, defect of one umbilical artery, malformation of the kidney, mental retardation.
Down's syndrome (Mongolism) (trisomy of chromosome 21)	Broad flat face, flat occiput, epicanthic fold, low set ears, hypotonia, deficient growth of limbs leading to short stature, snub nose, often malocculsion of teeth, double chin, abnormal genitalia, delayed puberty, mental retardation.
Turner's Syndrome (monosomy of X-chromsome)	Ovarian dysgenesis, amenorrhea, total infertility, failure of development of secondary sexual characters, cardiovascular defects, short stature, short neck with webbing of skin (loose redundant skin) of either side, cubitus valgus.
Klinefelter's syndrome (trisomy of sex chromosomes —XXY condition)	Seminiferous tubule dysgenesis, infertility, enlarged breasts, female like abdominal and facial hair development, eounchoidism, overt mental retardation.

of population control include among others a lower frequency of mongol children, decrease in the incidence of mental retardation, lower frequency of congenital defects, fewer cases of maternal-fetal incompatibility (like Rhesus factor) and a relative decline in consanguineous marriages (cousin marriage).

Our experience with genetic counselling is quite encouraging though not as dramatic as the experiences of fellow colleagues in other countries. For instance, among the 120 odd families approached by our group through the special schools for the mentally subnormal, 80 parents agreed to cooperate in our study, 20 had a negative response, and the rest preferred not to respond at all. During the course of personal meetings with the parents we were able to dispel their doubts, impress upon them the advantages of genetic counselling, and thereby change their outlook towards seeking such guidance. As a result, many parents consulted us about the likelihood of treatment or cure of their handicapped children. Still another group of parents wished to know the possibility of marrying their daughters, who were mentally subnormal, in view of the greater sexual urge seen in them. Much of our counselling, while certainly contributing to the understanding, acceptance, and control of genetic disease, did produce favourable results.

Genetic counselling should always be imparted by a team of experts. The results in a complicated case should always be communicated to the prospective seeker by the family physician or some other individual best qualified for the task. It is imperative that a human geneticist, with extensive training, should form the core of every genetic counselling team.

Genetic counsellor to match 'would-be couples'

If genetic counselling is sought prior to marriage as part of family education, immediate causes of mortality due to ABO and Rh incompatibility, anemia, malnutrition, miscarriages, still-births or the birth of babies with congenital defects, can be prevented. Such counselling would also help in overcoming physical and psychological problems related to the period from puberty to menopause in women. Counselling before marriage would help couples form a scientific attitude towards sexual needs and desires as also for a healthy sexual awareness to the phenomenon of procreation.

The lack of general awareness for seeking genetic counselling services, especially in our country, is perhaps because of numerous restraints of our society and culture. In India even today many deliveries in the low income groups, especially in rural areas, are handled within one's own house with the help of midwife. This not only deprives these parents of expert medical advice and services beneficial for their children but leads to infant mortality due to environmental factors. On the contrary, seekers of the services of amniocentesis in metropolitan cities of our country often misuse the information of such genetic counselling in deciding in favour of a particular sex of the child ! This should be strongly discouraged by the genetic counsellor. In the interest of the population at large, such counselling centres should be established in regions where infectious diseases and nutritional disorders are under control and the relative importance of hereditary disorders is increasing, and in areas where genetic disorders have always constituted a serious public health problem. Very special considerations apply to areas with high frequency of sickle cell anemia and thalasaemia (a genetically determined defect of hemoglobin synthesis) as they require a special genetic counselling for carriers as well as suitable medical facilities for the care of afflicted individuals.

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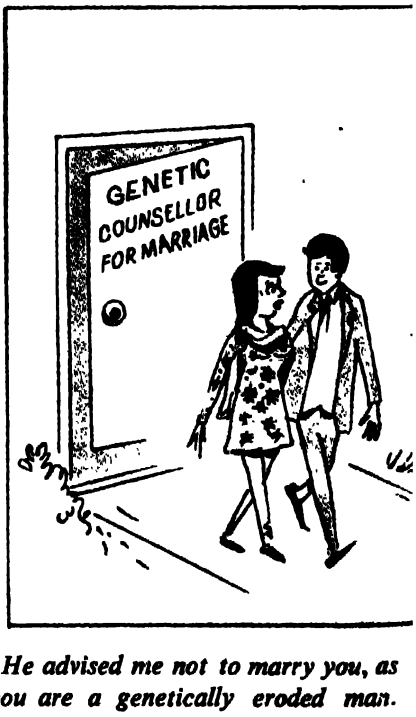
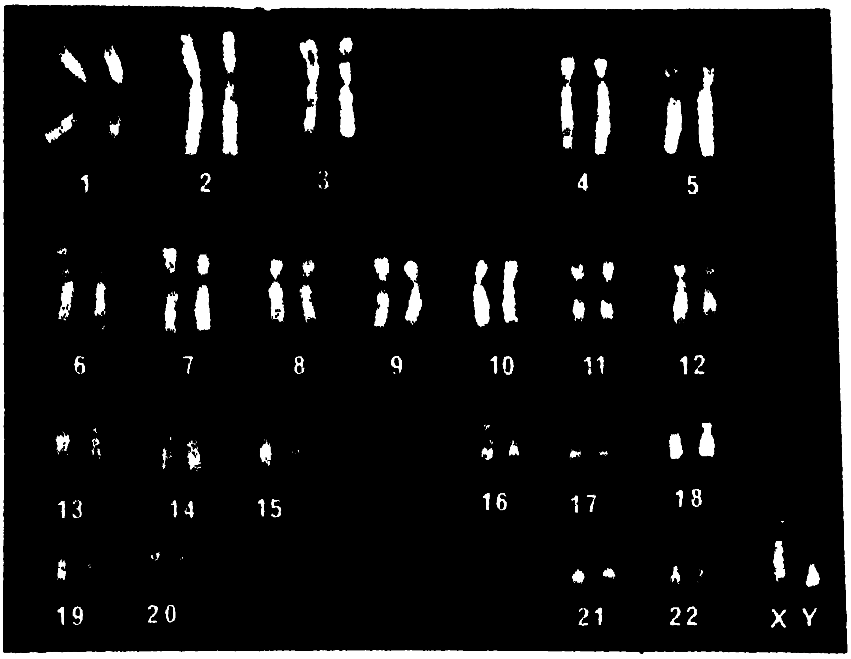


"He advised me not to marry you, as you are a genetically eroded man. What does it mean, any way?"



Human chromosomes

Some 200 genes in human chromosomes mapped

MUCH progress has recently been made in genetic mapping of the location of at least one gene on each of human chromosomes. Altogether, about 210 human genes have been mapped and assigned locations on one or other chromosome. In man, the specific chromosome that carries each of about 210 gene loci is now known. These loci include at least one assigned to each chromosome (including the Y), about 110 assigned to specific autosome, and about 100 to the X chromosome. For many loci, information on regional chromosomal localization is also available. Although some of these locations have been known for a long time, more than half the assignments have been made within the last five years. Five years ago, 86 gene locations were known on the X chromosome. The number known on the non-sex chromosomes was under 10. Though some of the fine detail is now coming into light, most of human chromosomes is still unmapped territory. The total numbr of human genes determining all manners of hereditary traits is estimated at 50,000. For 1,000 of these, there are some clues as to the group of chromosomes on which they are located, but that is all. Mapping of human genes is important for understanding evolution, the nature of some cancers and birth defects and potentially for diagnosis of serious disease while a baby is still in the womb. Recently, Drs. Victor A. McKusick of Johns Hopkins University and Frank H. Ruddle of Yale University summarized advances in gene mapping made by scientists throughout the world *Science*, 196, 390, 1977). The mapping information came mainly from studies in families and somatic cell hybrids, as well as a combination of results from the two methods.

B. D.

THE WORLD OF NEUTRONS

Neutrons can be put to a variety of uses

SURESH GARG
NARESH KUMAR

NEUTRONS, which form one of the two building blocks of atomic nuclei, were discovered in 1932 by the English physicist James Chadwick. A whole field of research "Neutron physics", based on their properties, has come into being now.

Our ideas of nuclear structure have also crystallized due to them. Besides, their vital role in the liberation of energy from matter through a nucleus fission reaction (both for peaceful and destructive purposes) is well-known.

Discovery

The existence of a neutron as a composite particle (of a proton and an electron) was first postulated in 1920 by Ernest Rutherford (U.K.) in a lecture given before the Royal Society. The need for this was to circumvent certain difficulties associated with the structure of atomic nuclei. The real existence of these particles was, however, demonstrated only in 1932 by Chadwick through the bombardment of beryllium nuclei with alpha particles (nuclei of helium atoms). As their very name indicates, they are neutral particles having no charge. Their mass (1.67×10^{-24}g) is only slightly greater than that of protons, their co-mates within the nucleus of an atom. They, alongwith protons, are collectively called nucleons.

Before the discovery of neutrons, it was believed that atomic nuclei contain electrons and protons. Heisenberg's uncertainty principle was clearly opposed to the presence of electrons within nuclei. The discovery of neutrons, however, gave support to the uncertainty principle, removed certain ambiguities in nuclear structure data, and gave a new direction to further research.

Neutrons, like most other fundamental particles, have their anti-particles called anti-neutrons. Neutrons and anti-neutrons differ only in their magnetic moments; the magnetic moment of one being the opposite (in sign) of the other. When a neutron and its anti-particle combine, they annihilate each other.

Structure

As against the general belief, neutrons may have an inner structure of their own. Clues to this structure are provided by their radioactive nature and their coexistence with positively charged protons within atomic nuclei.

Neutrons are bound in nuclei through very strong, short-ranged

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and attractive forces called nuclear forces. To explain the presence of these forces, it is believed that all nucleons continually keep on emitting and re-absorbing some light particles called π-mesons. All nucleons may thus be supposed to have at all times a cloud of mesons around their central core.

Once free, a neutron radioactively decays into a proton, an electron and an anti-neutrino with a half-life of about 12 minutes. Very crudely a proton may then be visualised to form the central core in a neutron and the electron-neutrino pair may be thought to originate from the meson cloud surrounding the proton core. This picture of the structure of a neutron is supported by the observation of a magnetic moment (−1.91 nuclear magnetons) for the neutron, as well as by the decay of 'free' charged π-mesons into electrons and neutrinos.

Various experiments (electron-neutron scattering) conducted to explore further the structure of the neutron have, however, discounted the above picture. They seem to suggest that there is no central positive core in a neutron as distinct from a negative π-meson cloud. Instead, they suggest that a neutron is electrically neutral throughout its volume.

Classification

Most of the spectacular uses of neutrons are because of their lack of charge. Being so, they enter almost unhindered (without the effect of any electric and magnetic field) in any material whatsoever. They, however, do loose some energy in each atomic collision and sometimes come to a stop in a head-on collision with an atomic nucleus.

Table 1. Classification of

Category	Energy range
Fast neutrons	>1 KeV
Slow neutrons	<1 KeV
Thermal neutrons	0.15–0.005 eV
Cold neutrons	0.005–0.001 eV
Ultra-cold neutrons	<0.001 eV

*1 KeV = 10^3 (electron volt); 1 eV = 1.6×10^{12} erg

Neutrons in their interaction with matter behave both as particles and waves (de Broglie hypothesis.). At slow speeds they loose their particle characteristics and behave as waves. The slower is their speed, the greater is their wavelength. The utility and character of neutrons thus change tremendously with their speed. In general, the wavelength of the associated de Broglie waves needs to be of the same order of magnitude as, say, the spacings between atoms in a

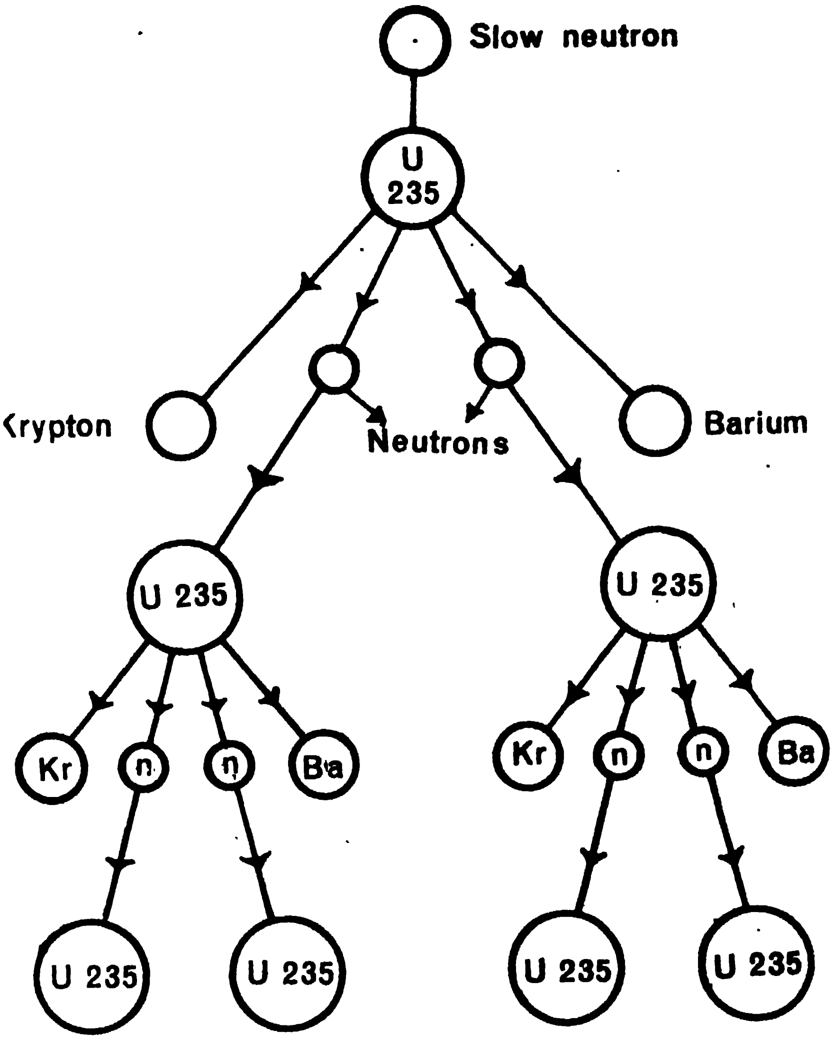

Fig. 1 Neutron induced chain reaction

Neutron bomb

INFORMATION on the mechanism of neutron bomb, also called the neutron warhead, is highly classified. However, according to available reports, the neutron bomb is based on thermonuclear fusion of fuel such as hydrogen unlike the conventional hydrogen bomb in which the fusion reaction is activated by a nuclear fission reaction. The fusion reaction in a neutron bomb is probably ignited by a non-atomic fuel such as the TNT.

A neutron bomb, it is believed, emits an intense flux of high-energetic neutrons. These neutrons can destroy all living organisms by disrupting their cells. A neutron bomb, unlike the atom bomb, is reported to have the potential of killing people without causing any blast and heat damage to property.

It appears that miniaturization work on neutron bombs has been going on since early fifties, both in the U.S.A. and Russia. Now these bombs are available even as 20 cm artillery shells.

A shield of 15cm thick concrete or 60 cm thick wood can absorb the emitted neutrons from these bombs. For unshielded troops on the warfront, neutrons from such a bomb may mean instant death.

There are, however, two puzzling factors in the reports available on the mechanism of such a bomb. It is not clear as to where the enormous amount of energy released in a fusion reaction goes. This energy should cause blast and heat-damage to buildings. Secondly, it is not apparent how a fusion reaction is achieved with a fuel like TNT, and that too in a device of such a small size, when scientists have so far failed to achieve thermonuclear fusion in a controlled way without an initiating fission reaction in a laboratory.

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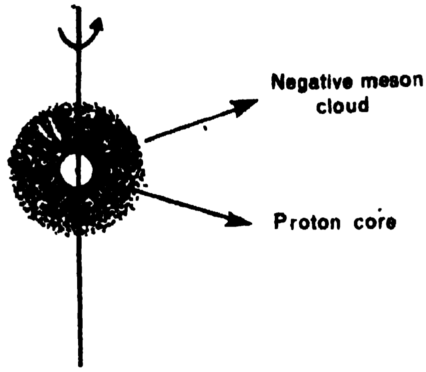

Fig. 2

crystal whose properties are under investigation. As neutrons of any speed (or kinetic energy) can enter any material, usually their best speed for accomplishing a particular job is first chosen.

Neutrons for different tasks are classified (Table 1) according to their energy content. Two main categories are the 'slow' and the 'fast' neutrons. Most of the spectacular applications of neutrons result from the use of slow neutrons. It is because the slow neutrons have a larger probability of interaction with most materials than the fast neutrons.

Thermal neutrons constitute an important category of neutrons. They are the ones whose average kinetic energy is approximately equal to that of the atoms (or molecules) of the medium in which they get scattered. The average speed of thermal neutrons is 2.2×10^5 cm/s. Fast neutrons of 1 MeV (10^6 eV) energy have a speed of 1.4×10^9 cm/s.

Neutrons are generally obtained from two sources. One is by exciting neutron-producing reactions, and the other as a by-product of a fission chain reaction in a nuclear reactor. Both these sources usually produce fast neutrons which are generally slowed down before use by passing them through a moderator such as heavy water.

Owing to lack of charge, neutrons do not interact appreciably with electrons. This does not allow them to cause appreciable ionisation in any material which eventually poses difficulties in their detection. They are therefore usually detected indirectly, from the ionisation of some charged particles which they release while interacting with some materials.

Applications

Neutrons are extensively used both in pure scientific research and in applied fields. Given below are the wide variety of ways in which they affect our lives.

Nuclear fission. Soon after their discovery, i.e., in 1939, neutrons found for themselves probably the most important use they have ever been put to. This was in the liberation of energy from matter through a nuclear fission chain reaction. The release of energy in such a reaction is governed by Einstein's mass-energy relationship ($E = \Delta m c^2$) and takes place when slow neutrons are bombarded on some fissionable material like uranium-235. This energy was used for destructive purposes in the form of atom bombs in the Second World War. Now this energy is being utilised on a very large scale for generation of electric power in nuclear reactors and for running of submarines in oceans.

Radioisotopes. Another significant use of neutrons is in the production of radioisotopes. Most of the radioisotopes available today are produced by the bombardment of

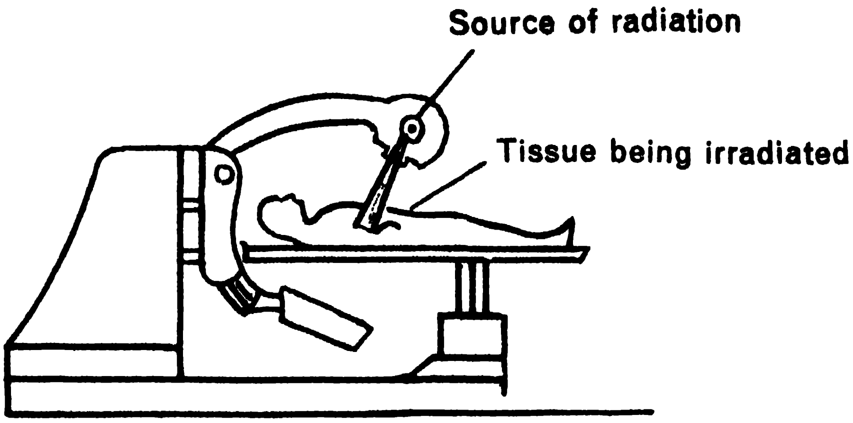

Fig. 3

naturally occurring isotopes with neutrons generated in a nuclear reactor. Radioisotopes have innumerable uses in almost all branches of science. Their contribution in the therapy of some lethal diseases such as cancer is well-known. Their utility as 'tracers' in scientific research is of great value.

Nuclear research. Neutrons have played a significant role in nuclear research. Proton-neutron scattering experiments, have been used to infer basic nuclear force between nucleons within the nuclei. From certain reaction the properties of nuclear levels are deduced, which in turn provide information on the structure of atomic nuclei. Further, neutron bombardments of heavy nuclei have been used to form transuranic elements, i.e., elements with atomic number greater than 92.

Neutron therapy. In advanced countries, fast neutron beams are now also being used for therapeutic work. Their potential in curing diseased tissues, say, those of cancer, is receiving the attention of medical personnel the world over. This is because they cause less damage to the tissues than other forms of radiation.

Activation analysis. Neutron activation analysis with both slow and fast neutrons is used for determining the elemental and/or isotopic composition of materials. In this, the relevant material is exposed to a beam of neutrons and the residual radioactivity (on the reaction product) is measured. An important feature of this analysis is that it is relatively very fast, and as such is suitable for industrial control problems. Some applications of this technique are in copper ore sorting, analysis of coal, and in measurement of salt and sulphur in crude oil.

Breeder reactors. One of the later uses of neutrons is in breeder reactors which produce more fuel (fissionable material) than they consume. These reactors generally use plutonium-239 as fuel which is covered with uranium-238 as a blanket. Fast neutrons liberated from fission of plutonium-239 convert the surrounding uranium-238 into more plutonium than actually consumed. Such reactors promise an unending supply of nuclear power for the generation of electricity. With the depletion of fossil fuels (coal, natural gas, etc.), these reactors are our long term hope for meeting future energy demands.

Neutron radiography. Neutron beams are also used for non-destructive testing of heavy and complicated parts of machinery by taking their photographs with neutrons. This technique is highly sensitive

Neutron stars

ORDINARY stars (with mass >1.4 times the solar mass) in their evolutionary stage sometimes end up as neutron stars. These stars having a diameter of about 10 km to 20 km are composed mainly of very densely packed neutrons (about 80% neutrons, 10% protons and 10% electrons). The density of their constituent matter is about 10^{14} gm/cc. Density of the heaviest known element on earth is only 21 gm/cc.

During the contraction stage of a star when its density is around 10^{10} gm/cc, a process of inverse β-decay sets in. In this process electrons combine with protons to form neutrons and neutrinos. This is responsible for most of the neutron content of neutron stars.

Neutron stars rotate at very high speeds (usually several rotations/sec). They have very strong magnetic fields of the order of 10^{12} gauss. We receive electromagnetic pulses from them at extremely regular intervals of time (ranging from 0.033 to 4.0 for different stars). They are therefore also called 'pulsars' or pulsating stars.

It is believed that neutron stars, like the sun and most other stars, are subject to some violent surface storms spraying particles and radiation into space. Each storm occurs in a localised area on the star and sprays out radiation in a narrowly defined direction. When our earth lies in the path of that radiation, our radio telescopes pick up their signals. As neutron stars are believed to spin around their axes, the signal is received only once in each rotation. This appears to be the explanation for the regular time interval between the successive pulses which we receive.

S.G.
K.K.

for the detection of manufacturing defects like those in welding and casting of components.

Hydrogen bomb. An important use of neutrons, though quite an unpleasant one, is in the mechanism of hydrogen bomb. This bomb is based on the conversion of thermonuclear fusion of hydrogen nuclei into helium gas. Thermonuclear fusion in such a bomb is ignited by a fission chain reaction which in turn is initiated by slow neutrons. In short, slow neutrons act as a basic tool for activating a hydrogen bomb.

Astrophysical problems. Neutrons capture reactions conducted on earth are proving useful in understanding astrophysical problems connected with heavy element production in stars.

Solid state physics. Neutrons have proved very useful in investigating the properties of materials as well as liquids. Slow neutrons scattering experiments have been used to infer crystal structures and vibrations of atoms in crystals. For investigating relationships of physical properties with atomic patterns in crystals, fast neutron scattering experiments have been conducted. These experiments have also been performed to change the properties, such as hardness and the ability to conduct heat and electricity, of metals. Slow neutrons are particularly useful in investigating crystal structures of hydrogenous compounds and magnetic properties of materials where X-ray studies completely fail. All these are of immense use in industrial problems.

Another important use of neutrons which is yet to prove successful is in the production of superheavy elements. These elements, only recently discovered, may be produceable by a multiple-neutron capture process. In such a process the target nucleus increases its mass by capturing many neutrons and increases its atomic number by a process of continued β-decay. Such a process is known to occur in stars at the time of supernovae explosion.

From the above it is clear that the uses of neutrons are so varied and so many that we have to mention them only briefly. When neutrons were discovered by Chadwick nobody perhaps imagined that such 'innocent looking' particles could accomplish so much in so short a time! Of all the fundamental particles neutrons have the distinction of being the only ones on whom a branch of physics is based. The future is sure to bring further glory to them—as new possibilities of their use are bound to open up.

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CORRIGENDUM

(i) In the article **Use of Transistor as a Switch** (*S.R.* September 77) there are following errors. On page 560, caption to Fig. 1. *read* $V=E$ *for* V-E; on page 561, first column, in 2nd paragraph, 7th line *read* $C_1=C_2=C$ *for* $C_1+C_2=C$; and in fourth paragraph, 10th line *read* $C_1=C_2=0.01\mu f$ *for* $C_1=C_2=0.01\mu$

(ii) The authors of the article **Of Pollen and Spores** (Science for the Young section, *S.R.*, September 1977) are Anup Kumar and Sunil Chaturvedi

(iii) In the article **Magic Squares** (*S.R.* July 77) there are following errors. On page 464, 2nd paragraph under "Definitions and formula" in 3rd line, omit % and *read* 1 *for* I and in line 5, omit %; page 465, 3rd paragraph under "Magic squares with desired constants", the first sentence should read as:

Thus, if M_B is the basic magic constant and M_D is the desired magic constant and N is the order of the square, then the starting number is $\{(M_D - M_B / N)\}+1$

POWDER METALLURGY

P. RAMAKRISHNAN

Powder metallurgy offers a versatile technique for shaping powders of metals, alloys, ceramics and complex engineering products

THE production of metal components from powders is a unique technology. It is now used not only for metals but ceramics, polymers and a variety of composite materials as well. More and more materials engineers, production engineers and designers are turning towards powder metallurgy because the products can be made porous or dense as desired. They can be made with a much wider range of properties than cast and wrought products. What is more, these products can be made rapidly, automatically and more economically.

Traditionally powder metallurgy is used when conventional melting presents difficulties, when incompatible elements and systems have to be handled or when the machining costs and scrap losses have to be avoided. Metal powders are converted into useful products by compacting them into the desired shape and size and sintering, sometimes followed by secondary operations. Many of the complex mechanisms that are responsible for transforming the metal powders to useful products of predetermined properties are not yet fully understood.

In recent years, the traditional powder metallurgy has undergone many changes. It is no more limited to relatively small parts that can be made with a punch and a die in a press. New techniques have been developed to manufacture larger and more complex parts. Powders can be directly rolled to produce strips and other flat products or can be extruded or forged to produce shaped objects with high strength properties. Today the technology is used for processing highly sophisticated materials with exceptional properties that are required for nuclear engineering, electronics and aerospace applications. The products which are successfully produced by powder metallurgy include porous self-lubricating bearings, filters, structural components, metal-carbon products, high temperature materials including dispersion strengthened alloys, magnetic materials including ferrites, cermets and other composites. There are several technical and economical benefits of processing high-speed steels, special alloy steels and super-alloys by powder metallurgy.

The process

Powders of required constituents and composition are blended to produce a mix, which is compacted to the desired size and shape and sintered in a furnace in a suitable atmosphere at a certain temperature

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Fig. 1. Electron micrograph of electrolytic iron

for a definite time period. The sintered products are then subjected to secondary operations such as coining, impregnation or infiltration or are further compacted by rolling, extrusion or forging. Many of these products can also be heat treated to improve their properties.

Powders can be produced by atomisation of liquid metals and alloys, chemical reactions, electrolytic deposition or by mechanical processing of solid materials. Many of the metal powders, particularly iron, can be prepared directly from their ores or oxides by direct reduction with hydrogen, hydrocarbon gas or carbon. Several powders are produced by the electrolysis of aqueous or fused salt solutions. Powders of copper, nickel and cobalt can be produced by the pressure leaching of ammoniacal solutions of ore concentrate or scrap which offer an economical source of high purity powders.

For compaction, the powder blend is fed into a die and compressed in mechanical or hydraulic presses. The components for compaction usually consist of die body, upper and lower punches and core rod, as shown in Fig. 2. First the upper punches are completely withdrawn from the die and the die cavity filled with the blended powder through a feeder. Then either the upper punches are brought down or the upper and lower punches are simultaneously moved to compress the powder into the desired shape. The compacting pressure varies from a few tons to several tons depending upon the type of material and the density required. Subsequently, the top punches are withdrawn and the compacted part is ejected from the die. During compaction the porosity is reduced and density increases by powder particle movement, deformation and fracture. The bonding produced by cold pressing results from the mechanical interlocking and cold welding at the point of contact between particles. The simple die compaction has now undergone many developments. They include high energy rate forming, explosive forming, isostatic compaction, hot pressing, powder rolling, extrusion and forging.

The compacted parts are sintered by passing them through a furnace under a controlled or protective atmosphere maintained at a temperature below the melting point of the principal constituent. During sintering the metal powders are transformed into a mass in which the individual powder particles lose their identity. Subsequently, recovery, recrystallisation, grain

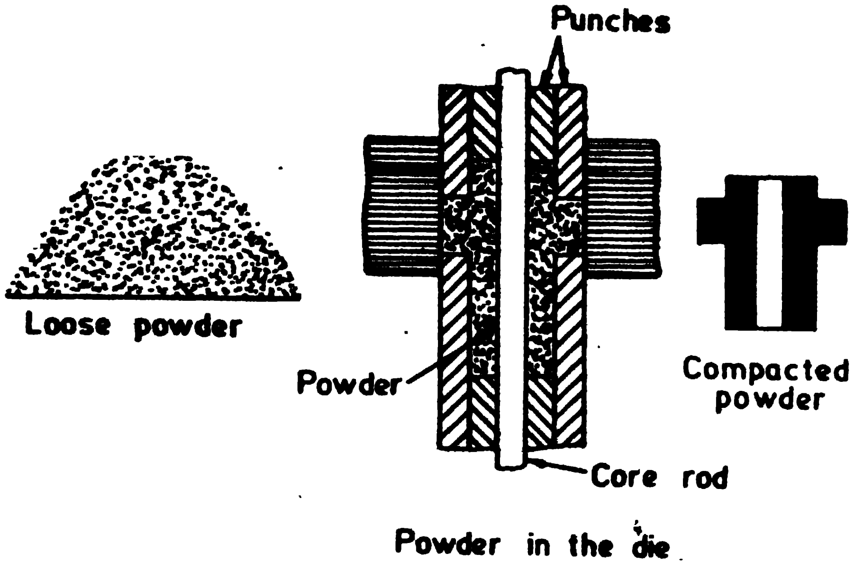

Fig. 2. Compaction process

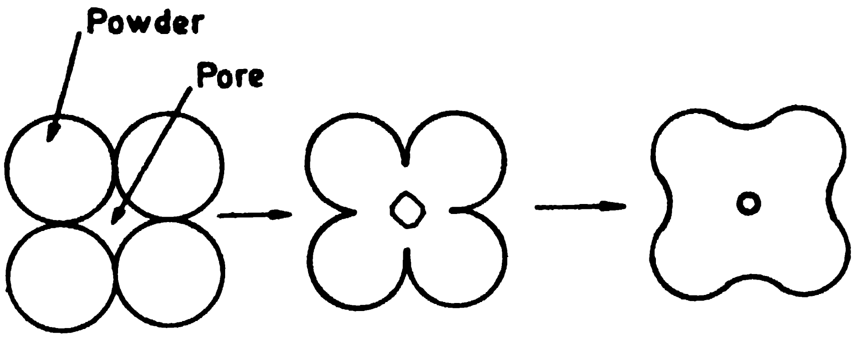

Fig. 3. Pore structure changes during sintering

growth, and alloying result in good bonding. The pore shape and size change as shown in Fig. 3. Sometimes transport mechanisms including various diffusion processes, creep deformation, evaporation and condensation also come into play during sintering. The mechanical properties of the compact is improved considerably through sintering.

In addition to the separate stages of compaction and sintering, it is possible to combine compaction and sintering by hot pressing. This technique is widely used for ceramics, refractory metals, special alloys and composites. In addition to solid state sintering, liquid phase sintering is also used in which one or more components of the material is present as a liquid phase. A modified form of this technique is the infiltration of a molten metal through the porous structure of another material. These techniques are used for the production of self lubricating bearings, cemented carbides, electrical contact materials, etc.

Although the sintered parts are normally ready for use, subsequent processing is necessary when very close tolerances are specified or increased density is desired. Bearings and many structural parts are oil impregnated for lubricating purposes or for corrosion resistance. During impregnation, preferably in vacuum, the sintered parts absorb oil readily because of their porosity. The pores of powder metallurgy products can also be infiltrated with a metal or alloy of lower melting point. Generally the slugs of an infiltrant material are placed on the compacted parts and passed through the sintering furnace, when the infiltrant melts and penetrates into the pores. The mechanical properties are improved considerably because of the dense structure of the product.

Depending upon the requirements the parts can be subsequently coined, steam treated, rolled, extruded, forged or heat treated to improve the properties. Many of the powder metallurgy products for advanced and high performance applications are processed to full density to take advantage of their superior mechanical properties. Normally in alloy formation the constituents exhibit a strong tendency to segregate during solidification which leads to local variations in composition and structure. But in powder metallurgy, since each powder particle is an alloy, the products are free from segregation and result in improved mechanical properties than the corresponding conventional cast and wrought products.

Developments in our country

Powder metallurgy industry is still in its infancy in our country. Production of powder metallurgy products such as bronze and iron bushes started only in 1958. Since then considerable progress has been made. Nowadays a variety of components such as self-lubricating bearings, bushes,

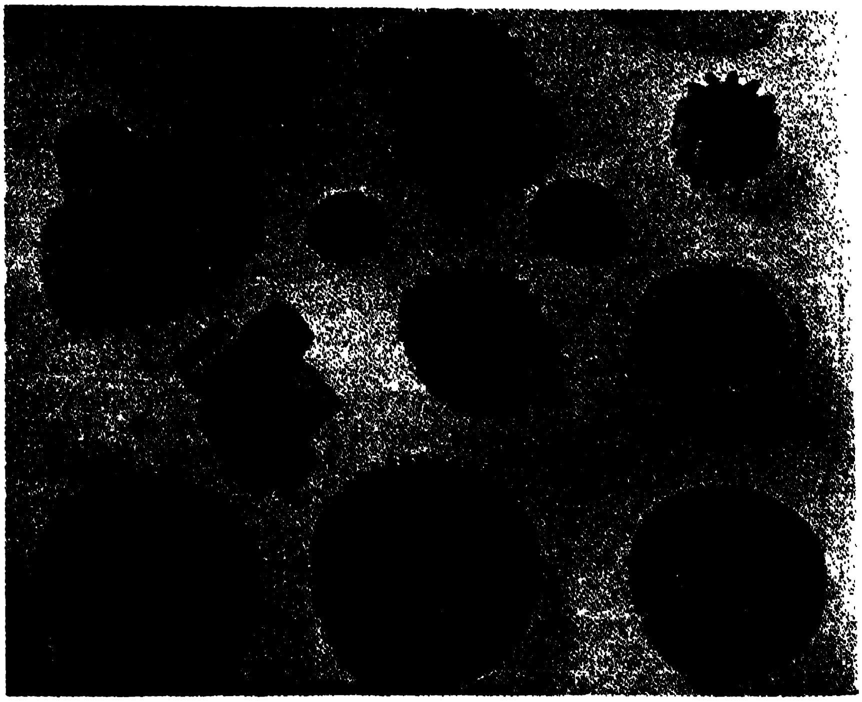

Fig. 4. Some powder metallurgy products

filters and structural parts are made and used in automobiles, scooters, electrical fans, home appliances and textile machinery. Considerable savings have been achieved by the use of these products. Cemented carbide products such as cutting tools, drilling rods, bits, dies and other components are also made in substantial quantities. Other products include metal graphite brushes, contact materials and ferrites. Powders such as aluminium, zinc, tin, silver, magnesium, tungsten, copper, iron, etc., are also made in good quantities. The production of special powders such as bronze, copper-lead, copper-lead-tin, etc., will also be scaled up in the near future. Considerable research and development work is being done in the field of powder metallurgy in our national laboratories and technological institutions.

Powder metallurgy as a fabrication technique plays an important role in the development of atomic energy. It is used for the production of fuel elements, cladding materials, moderator and control rods. Bhabha Atomic Research Centre, Bombay has done much work in this field. The know-how developed by BARC is being utilised by the Nuclear Fuel Complex at Hyderabad for the fabrication of fuels for reactors at the Tarapur and Rajasthan Atomic Power Stations. Work is also going on a number of high temperature materials like molybdenum, cermets and certain fissile materials like thorium. At Vikram Sarabhai Space Centre, Trivandrum, work is in progress for the development of materials for extreme high temperature applications like jet vane, rocket throat inserts, etc., made out of refractory materials. Beryllium powder metallurgy products are used for sophisticated instrumentation system required for guidance and control. Scientists at the National Aeronautical Laboratory, Bangalore, are studying the production of reactive metal powders such as titanium, zirconium etc., by vacuum atomisation. Defence Metallurgical Research Laboratory, Hyderabad, has done extensive research and developmental work in the field of cemented carbides, sintered ordnance components, isostatic and explosive compaction and a variety of products such as contact materials, cermets, ferrites, and dispersion-strengthened materials. Extensive research and development work is going on in the field of powder production, sintering, development of sintered products at BARC, DMRL, National Metallurgical Laboratory, Jamshedpur, Central Electro-Chemical Research Institute, Karaikudi and various other institutions.

Powder metallurgy research and developmental work have been pursued at IIT, Bombay for the past 16 years. These include powder production, characterisation, sintering, structure-property evaluation of sintered products, ferrites, composite materials, hot pressing, powder rolling and preform forging, etc. Even though tungsten is made by powder metallurgy, sintered tungsten bars and rods are not so far made in our country and these are imported and subsequently processed to produce bulb filaments and other products. A public sector enterprise has been recently set up by the Government which is expected to produce in the near future, tungsten and molybdenum products alongwith other advanced materials such as titanium base alloys and a variety of super alloys.

Powder metallurgy know-how developed

INDIA has achieved significant success in the advanced technology of producing metal powders.

Some national Laboratories under Council of Scientific and Industrial Research have developed processes for the production of metal powders of iron, zinc, copper, lead, tin and brass. They have also developed processes to produce powder alloys of two or more metals.

Powder of metals are used in sophisticated industries such as manufacture of engines, machines tools, pigments, and electrical appliances. At present most metal powders are imported.

The know-how of the National Metallurgical Laboratory, Jamshedpur, for producing extra fine metal powders of non-ferrous metals such as copper, aluminium, tin, lead and brass has been worked out on pilot plant scale. The Jamshedpur Laboratory has also produced extra fine zinc dust for use in chemical industry. The demand for fine zinc powder in India is 6,000 tonnes which is presently imported.

The NML process produces extra fine zinc dust, both from pure zinc metal and from industrial wastes containing zinc. In another experiment, the Jamshedpur Laboratory has successfully produced the alloy powders of copper, lead and bronze. These powder alloys are used in the manufacture of engines.

Another CSIR laboratory, Central Electro-Chemical Research Institute, Karaikudi, has developed a process for producing powder of iron by electrolytic method. Iron powder is used in machine building industry. The CECRI know-how can produce fine iron powders from low-grade iron ores also. The Institute has also developed the know-how for annealing of iron powder so obtained.

ANTIDIARRHOEAL DRUGS
—Safe or Unsafe?

H. H. SIDDIQUI

There is an international debate on the "toxicity" of the anti-diarrhoeal drugs in common use today

EXCESSIVE preoccupation with drug toxicity rather than objective appraisal characterizes much of the recent newspaper reports on the toxicity of Entero-Vioform (Commercial names of the drugs have been used in the article because readers are more likely to be familiar with them) and Mexaform. This was based on an article published in *Lancet* (1977).

According to Charaka (about 1000 B.C.): 'A drug that is not understood perfectly is comparable to poison, weapon, fire and thunderbolt, while the well-understood drug is comparable to ambrosia'.

I am reminded of the sayings of Oliver Wendel Homes (1860): 'I firmly believe that if the whole *Materia medica* as now used, could be sunk to the bottom of the sea, it would be all the better for mankind—and the worse for the fishes.' 'Why this hue and cry over Entero-vioform when every drug has adverse effects on some people?', asks Professor U.K. Sheth of Bombay.

These quotations warn us of potential toxicity of all drugs of all times including modern drugs. And therefore the problem of Mexaform toxicity also requires thorough scientific assessment. At the same time there is no reason for creating panic and fear in the minds of people. Drugs like Dependal, Dysenchlor, Entero-Quinol, Entero-Vioform, Folestine, Intestopen-In, Mexaform and Unienzyme have been used in India for several years and till today no epidemic of the nature discussed in the English medical literature has been noticed by clinicians.

Halogenated hydroxyquinoline

The development of antidiarrhoeal and antiamoebic drugs is related with the visit of people from countries like Belgium, France, Germany, Great Britain and Holland during their Empire in the tropical countries. They used to suffer frequently from the tropical diseases. And this led to the development of drugs for tropical diseases. For dysentery, emetine and chiniofon were developed about 60 years back. The rational use of emetine as an amoebicidal drug dates from 1912 and had been most widely used. Chiniofon was the first drug of the halogenated hydroxyquinoline group used for the treatment of diarrhoea and amoebiasis. Fig. 1 shows the chemical structure of quinoline, 8-hydroxyquinoline and some of its widely used halogenated derivatives.

Table 1 shows the commercial names, composition, official names and the therapeutic doses of commonly used drugs containing halogenated quinolines. These drugs are being used extensively in India to treat diarrhoea and intestinal amoebiasis. In acute diarrhoea,

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Table 1 ·Commonly used antidiarrhoeal, antiamoebic and enzyme preparations containing halogenated quinolines

Commercial name	Official name and composition	(per tablet)	Dose
1. *DEPENDAL*	Furazolidine	100 mg	1-2 tablets three times a day
(SKF)	Vioform	200 mg	
2. *DYSENCHLOR*	Chlorquinaldol	100 mg	2 tablets three times a day
(Surhid Geigy)			
3. *ENTERO-QUINOL*	Vioform	250 mg	1-2 tablets three times a day
(East India Pharm.)			
4. *ENTRO-VIOFORM*	Vioform	250 mg	1-2 tablets three times a day
(Ciba)			
5. *FOLESTINE*	Broxyquinoline	500 mg	1 tablet three times a day
(Sandoz)	Brobenzoxaldine	100 mg	
	Hyoscyamine	0.028 mg	
	Hyoscine	0.0026 mg	
6. *INTESTOPAN-IN*	Broxyquinoline	200 mg	1-2 tablets three times a day
(Sandoz)	Brobenzoxaldine	40 mg	
	Hyoscyamine	0.028 mg	
	Hyoscine	0.0026 mg	
7. *MEXAFORM*	Phanquone	20 mg	1-2 tablets three times a day
(Ciba)	Vioform	200 mg	
	Oxyphenonium	2 mg	
8. *UNIENZYME*	Diastase	200 mg	1-2 tablets three times a day
(Unichem)	Papain	30 mg	
	Thiamine	2 mg	
	Riboflavine	2 mg	
	Nicotinamide	25 mg	
	Diphenhydramine	20 mg	
	Vioform	125 mg	
	Homatropine	1.25 mg	
	Methyl polysiloxane	25 mg	
	Activated charcoal	75 mg	
	Acetophenolisatin	0.5 mg	

generally two tablets are taken three times a day. In most cases the treatment continues for 2-3 days. But in intestinal amoebiasis it is usually given for 7-10 days. Each packet of these drugs carries the warning: '*Relatively' prolonged and uninterrupted treatment with halogenated hydroxyquinoline derivatives used in high dosage for more than 14 days have been reported to cause peripheral neuritis and damage to the optic nerve in isolated cases.*'

Subacute myelo-optic neuropathy (SMON) and vioform

During 1956, many Japanese suffered from an unusual combination of gastro-intestinal and neurological complaints. The symptoms were abdominal pain, diarrhoea, followed within a few days or weeks by painful and persistant sensation induced by gentle touch of the skin—in addition to other sensory disturbances—and visual disorders due to inflammation of the optic nerves. This disease was called SMON. During the whole course of epidemic, which ran from 1956 to 1970, some 10,000 Japanese were afflicted by this disease. Only

180 cases have been identified outside Japan including 9 cases by Professor N.H. Wadia, an eminent neurologist of Bombay.

Greenish colouration of tongue, faeces and urine was noted in Japanese patients of SMON (Meade, 1975). The green colour is believed to be due to the iron chelate of vioform. It is not clear whether iron chelate is responsible for the damage of the nervous system. It is possible that the Japanese might be absorbing this chelate more readily or are more sensitive to it than others. The SMON toxicity of vioform has been observed to be dose-related. For example, at a dosage of 750 mg/day for 4 weeks or less, there is little risk of toxic reactions (Kono, 1971; McEwen, 1970, 1971). Neurological symptoms develop in approximately 1% of patients who take doses of 750-1500 mg/day for less than 2 weeks (Tsubaki *et al*, 1971; Nakae *et al*; 1971). Approximately 35% of patients who take doses of 750-1500 mg/day for longer than 2 weeks develop symptoms (Tsubaki *et al*, 1971; Yoshitake and Igata, 1971). A dose of 1800 mg/day causes the onset of symptoms as early as the 5th day (Nakae *et al*, 1971). Two of the case reports are particularly enlightening because they demonstrate, in individual patients, important quantitative points of vioform dose and neurotoxic response (Oakley, 1973). One of Selby's (1972) patients took 500 mg to 750 mg of vioform per day for more than a year without symptoms. Six weeks after he had begun to take 1500 mg/day, neurological symptoms developed. Kaeser and Wuthrich (1970) reported that neuropathy developed in a woman patient while she was taking 1500 mg/day . The neuropathy improved when the dosage was lowered to 750 mg/day, and became worse when it was again increased to 1500 mg/day.

SMON is a clinical condition which usually occurs after abdominal symptoms like diarrhoea and consists primarily of the damage of the spinal cord (myelopathy). There is also damage of peripheral nerves which is manifested by abnormal sensation (paraesthesia) in the lower limbs. In some patients involvement of the nerve of the eye (optic nerve) leads to disturbances of vision. SMON has only recently found its place in Western monographs and books on the diseases of nervous system although it is known to have afflicted Japanese and has been reported by them since 1956 (Meade, 1975). A voluminous literature on all aspects of the disease has accumulated in Japan, but there have been only occasional cases reported from Australia, France, Great Britain, Holland, India, Singapore, Sweden, Switzerland and U.S.A. (Wadia, 1977). The disproportionately high prevalence of this disease in Japan has been commented upon by the Japanese themselves.

Today the diagnosis of SMON outside Japan is largely based on the acceptance of the Japanese experience (Osterman, 1971; Selby, 1972). In day-to-day practice of neurology, one comes across patients who resemble those diagnosed as SMON but they differ in that they do not suffer from preceding diarrhoea or or other gastro-intestinal disturbances and may not have taken vioform (Wadia, 1977).

SMON in India

Professor B. N. Tandon, the Gastroenterologist of AIIMS pointed out (*personal communication*) that he has not personally come across any patient of SMON definitely linked with Entero-Vioform or other halogenated quinolines. He, however, stopped prescribing iodo or iodochlor derivatives of quinoline since Japan's report in 1970. In his view we do not have such adverse reports on the bromo derivatives of quinoline (Table 1). Professor Tandon's view is supported by the report of Professor N.P.S. Verma of Maulana Azad Medical College, New Delhi, who tried Intestopan in a dose of 480 mg three times a day for 5 days in a double-blind clinical trial for the treatment of diarrhoea. The study was carried out over a period of one year. He did not notice any case of SMON.

Gangadhar Sharma (1975) has reported remarkable clinical improvement in lepromatous lesions with Intestopan Forte capsule given three times a day for six months. This has been so far tried in 56 leprosy patients for upto one year. Throughout the period of therapy no serious adverse reactions have been encountered.

Professor V. Virmani, Neurologist and Prof. R. Batta, Opthalmologist (both of AIIMS) did not come across any case of SMON linked with halogenated quinolines (*personal communication*).

Professor N.H. Wadia of Bombay acquired first-hand knowledge of SMON during a visit to Japan in 1972. After his return to Bombay, he carried out retrospective search of over 5,000 case histories and prospective search of 4½ years and found only 9 cases of SMON. In these cases there was history of vioform intake, and therefore vioform could not be excluded as an etiological agent. Three cases resembling SMON were scrutinized from 1970-72 records by Dr. Gouri Devi, Neurologist, Safdarjang Hospital, New Delhi (*personal communication to Professor B.N. Tandon*).

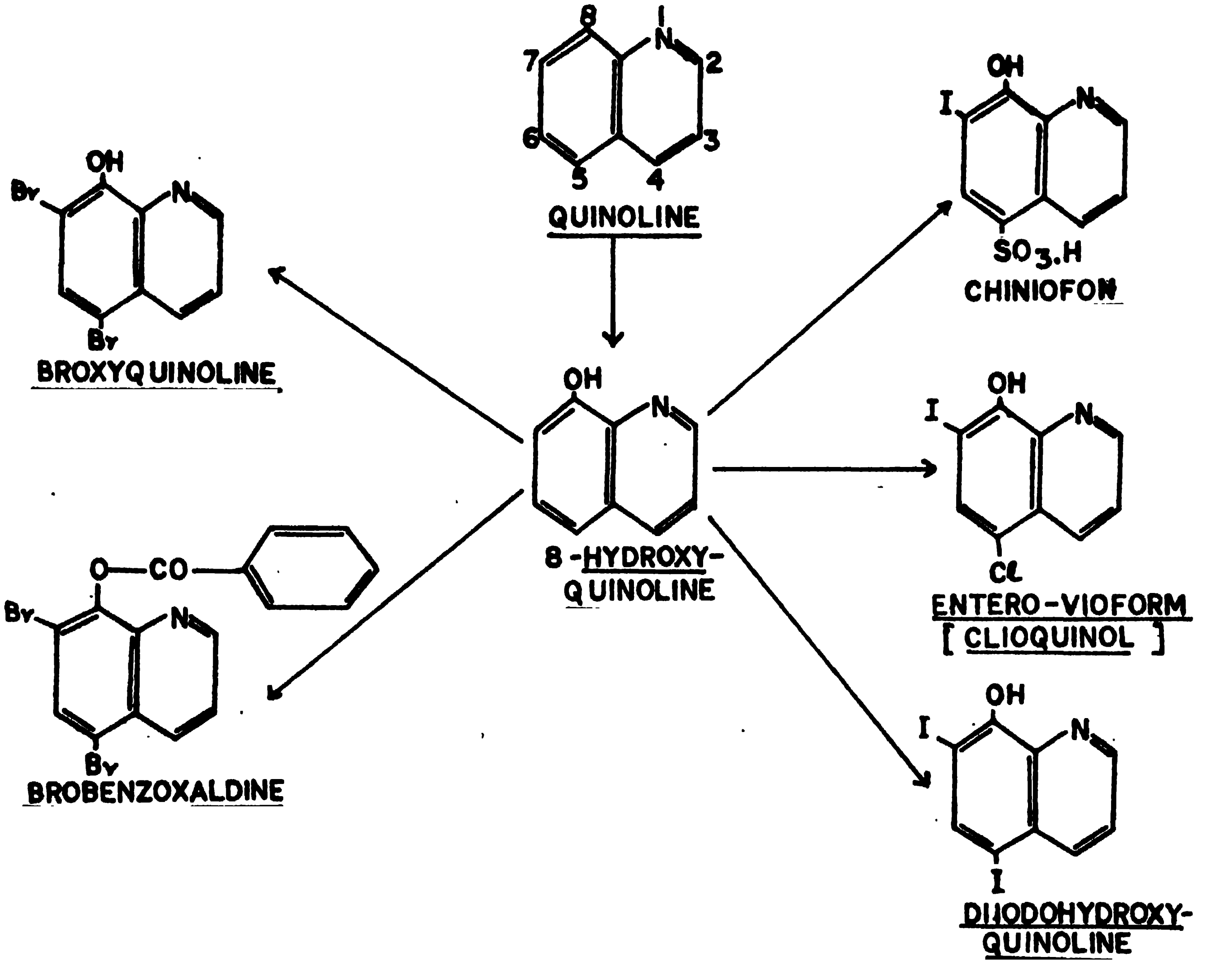
Altogether there appears to be 12 patients reported from India. These Indian patients differ greatly from their Japanese co-sufferers in that there was absence of abdominal complaints. Dr. Gouri Devi's three patients did not deteriorate even when they continued to take vioform. Wadia (1977) has stressed that against 10,000 cases of SMON reported from Japan over a 15 year period (Meade, 1975; *Lancet*, 1977; Iwarson, 1977) he was able to find only 9 cases in Bombay in 9 years. Even if there were 180 such cases throughout the world outside Japan, the number would be trivial, bearing in mind the number of people who have taken vioform. Professor Wadia (1977) thinks, and probably on sound reasons, that clinicians in and around big neurological centres in India would not have missed SMON cases after the Japanese experience.

Publicity—What next?

On the recommendations of the Indian Council of Medical Research, the Drug Control Authorities have now (Circular letter No. 12-105/70-DC, dt. 1.7.77) indicated that all halogenated hydroxyquinoline containing preparations be available to the public only on the prescription of a registered medical practitioner.

Several theories have been proposed about the etiology of SMON. It has been suggested that there is some factor in addition to vioform (if vioform is at all involved), for example, infectious etiology such as virus infection, several agricultural and environmental pollutants, possibility of racial or genetic pre-disposition leading to greater vioform toxicity, interaction of vioform with other drugs, etc.

Many persons in India (Wadia, 1977) take more than 10-40g of vioform, the dose deemed sufficient to cause SMON in Japan (Kono, 1971). Also, there are many Indians who are habitual users of drugs like Unienzyme for indigestion and flatulence. Unienzyme contains 125 mg of vioform besides other ingredients. It would be wrong to ban drugs like Entero-Vioform in a tropical country



like India in haste. The question of toxicity and activity should always be relative. In India, where a large number of people suffer from chronic gastro-intestinal disturbances, the benefit derived from taking these drugs should not be overlooked. However in 1977, it would be imprudent totally to ignore the Japanese experience. In India, more attention should be given to *Pahadis*, Nepalese and people from Nagaland who are ethnically more close to Japanese. If the factor responsible for SMON is genetic, SMON may never appear in India on an epidemic scale. But if the factor is environmental, infective or due to drug interaction, then SMON may appear in India also (Wadia, 1977).

Undoubtedly one should be vigilant about these drugs and for that matter about everything in life. But vigilance is not fear and panic. Panic and fear cause neurosis, impaired judgement and usually foster a temptation to take a wrong, unwise and cheap decision. Things should be done coolly if one has to do it. Here is an excellent advice from one of the wisest philosophers, George Bernard Shaw. It is a dialogue in his play Caesar and Cleopotra.

'*Rufio*: Now tell me : if you meet a hungry lion there, you will not punish it for wanting to eat you?

Caesar: No.

Rufio: Nor revenge upon it the blood of those it has already eaten.

Caesar: No.

Rufio: Nor judge it for its guiltness.

Caesar; No.

Rufio: What then would you do to save your life from it?

Caesar: Kill it, man, without malice, just as it would kill me.'

The same wise attitude must prevail in considering any problem in public life, drug or no drug.

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SCIENCE SPECTRUM

Cellulose in interstellar space

IT has been known for quite some time that complex organic molecules can form and exist in interstellar space, especially in the galactic dust clouds. In the last ten years or so more than 40 such molecules have been identified by using radio telescopes and infrared spectroscopy. The British astrophysicist Fred Hoyle and his associate N. C. Wikramasinghe have now confirmed the presence of polysaccharides in galactic clouds (*Nature*, **268**, 610 1977). Their findings are based on the close similarity between infrared spectra of interstellar solid material and the transmittance spectrum of the polysaccharide, cellulose.

It was known earlier that infrared spectra of interstellar dust clouds show strong absorption bands at wavelengths of 3 μm and 10 μm (1 $\mu m = 10^{-6} m$). The two bands were thought to be due to water-ice and magnesium silicate grains in the dust. On closer study, however, Hoyle and Wikramasinghe found that the correspondence of a silicate-ice model and the observed spectra was not quite good. But the observed spectra matched exactly with the infrared spectrum of cellulose which show absorption bands at both 3 μm and 10 μm.

How did the polysaccharides form? The two scientists believe they were formed by polymerisation of formaldehyde. With the exception of hydrogen (both molecular and ionised), water (vapour and ice) and carbon monoxide (CO), the most abundant molecule in the interstellar medium is formaldehyde (HCHO). This molecule can undergo polymerisation in many ways. (Such a polymerisation process could be initiated by the action of ionizing radiation.) The resultant polymers are quite stable. Among them, the common polysaccharides, cellulose and starch, are particularly so because each glucose unit ($C_6H_{12}O_6$) in these molecules can form itself into a very stable ring.

This new discovery points to the fact that very large molecules (macromolecules) can form and exist under interstellar conditions. It also shows that evolution of prebiotic molecules or a primitive biological system in interstellar space is a distinct possibility.

BIMAN BASU

India in collision with Eurasia

HAVE a look at the region called Eurasia. As every one knows, it is the land mass East of Ural mountains (U.S.S.R.) and North of Ganges. It embraces the region known as Northern India, Pakistan, Afghanistan, the Tibetan Plateau, Mongolia, most of China and a large part of Eastern U.S.S.R. Few know, however, that it is this land which has the greatest diversity in geology, topography and climate. It is here that the Himalayas, the highest mountains, Gobi Desert, the most inhospitable region, and Lake Baikal the deepest, are present. And it is doubtful how many know the reason behind this extreme diversity. Only one incident—surprisingly—caused all this. It happened, according to geologists, nearly 45 million years ago: the Indian continent collided with Eurasia. Even today this process is on, the former is pushing the latter at an average rate of five cm per year. (*Scientific American*, April 77).

Startled as you may have been, the fact remains that about 70 million years ago, the whole of the Indian subcontinent was down below in the Indian Ocean 7000 kilometers away. If an axis is drawn through India, from Kashmir to Kanyakumari, this was then tilted approximately between the geographical North-East and South-West directions. As the Indian continent began to "climb" up, the axis began to take a slow, lazy turn about its centre about 40 million years ago (Fig. 1). It began to align itself

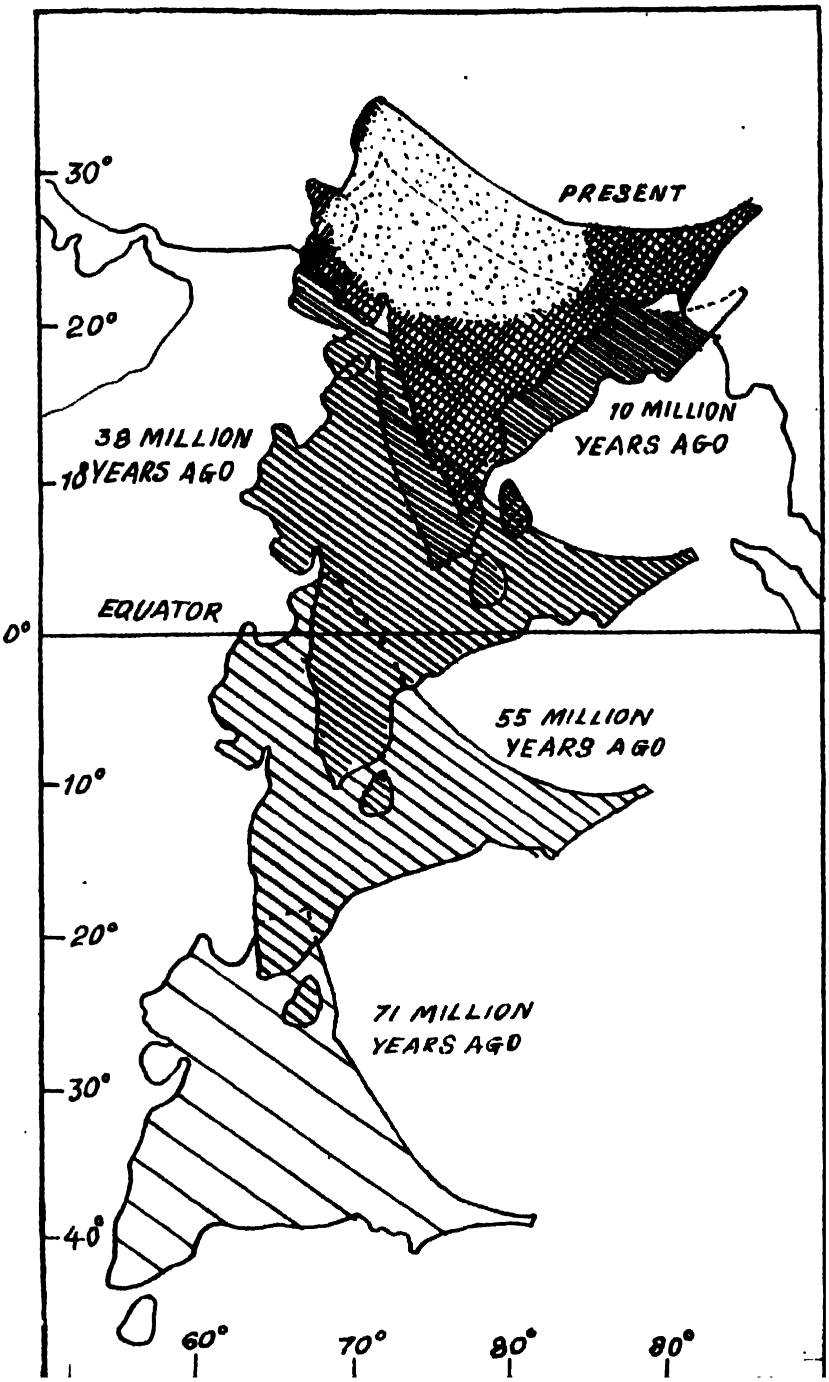

Fig. 1

along the North-South direction. The Indian continent was hastened up to do so when it collided with the Eurasian land mass.

Apparently, the two continents did not instantly merge their boundaries as they appear today. The merging was a gradual process. First they joined "hands" at one point and then slowly swallowed up the sea in between, and finally the real struggle between them ensued, which is still on.

This "jutting" up of Indian continent into the Eurasian land mass produced innumerable consequences. The Himalayas were produced, the Tibetan plateau and the Tien Shan range were raised. Apart from drastic changes in climate which resulted, some 3000 kilometers of land along north and east of Himalayas became prone to earthquakes. So much so that of the last 22 greatest recorded earthquakes, seven occurred in this region. Added to this are indications that China is being pushed along the NE-SW and N-S axes into the Pacific Ocean!

Geologically, how all this came about is the issue which cannot be avoided. For that, consider the plate tectonics theory. Imagine the surface of the earth comprising of thick rigid plates. These plates consist of earth's crust and some layers, and they float on the inner fluid layer of the earth known as mantle. Continents are those regions which ride on these plates which, being at higher elevations, stand above the water around. So, the Indian continent approached the Eurasian because of the internal plate movement. Their movement created the same consequences as are produced when a metal plate pushes a sheet of velvet. The land mass between their boundaries was raised vertically and compressed along the edges of the plates, pushing up mountains and creating a weak internal structure so as to become highly susceptible to earthquakes. China is being pushed northeastwardly into the Pacific because the land mass on the west side is much larger and heavier to push.

DILIP M. SALWI

Nature also is a polluter

THERE has been a lot of controversy in recent years over the pollution of rivers, lakes and the seas by pesticides and halogenated organic compounds like DDT, and the polychloro biphenyls (PCBs). Many industrial effluents contain halogen compounds which when discharged into water courses without pre-treatment cause pollution.

Till recently it was believed that such pollution was exclusively man-made. But it has now been discovered that nature also has a share in it. Halogenated organic compounds are now known to occur naturally in coastal waters; their source: the various species of seaweeds, molluscs, sponges and bacteria that abound in the marine environment.

Take the red algae, or Rhodophyta, for example. They synthesise an impressive variety of organic substances, many containing chlorine and iodine. The products range from low molecular weight halomethanes and ketones to higher molecular weight terpenes and fatty acid-like compounds. William Fenical, a scientist of the Scripps Institute of Oceanography, U.S.A, has listed more than 80 such halogenated organic compounds (*Environ. Sc. & Tech.*, May 1977). Among Fenical's findings is a red seaweed of the genus *Asparagopsis*, which produces small amounts of the toxic chemical carbon tetrachloride. Other compounds found in that same weed include bromoform and halogenated acetones. One such compound, monobromo acetone, is a principal component of tear gas.

Much of the evidence about these natural pollutants has come in course of screening of marine plants for pharmaceutical materials. None of the organisms tested so far has been found to produce substances similar to D.D.T. or related compounds. But that, Fenical cautions, does in no way reduce the significance of natural organohalogen compounds as pollutants. And for any evaluation of water pollutants, especially in coastal areas, this factor should be taken into account.

BIMAN BASU

Synthesis of element 106

THE element with the atomic number 106 is the fourteenth of the synthetic transuranium elements. The discovery of this element took place in 1974 nearly simultaneously in two laboratories, the Lawrence Berkeley Laboratory at the University of California, U. S. A. and the Joint Institute for Nuclear Research at Dubna near Moscow in the U.S.S.R. Neither group has suggested any name for the element. Consequently, for the time being, it will have the simple designation "element 106". On the basis of its projected position in the periodic table, element 106 is expected to have chemical properties similar to tungsten.

The Berkeley Group headed by A. Ghiorso used the Super-Heavy Ion Linear Accelarator as its source of heavy ions. They bombarded a target of californium (the isotope ^{249}Cf, atomic number 98 and mass number 249) with ^{18} O ions of energy 95 MeV and intensity 3×10^{12} ions per second. This resulted in the production of element 106 with the mass number 263, which decays with a half-life of 0.9 ± 0.2 sec by emission of alpha particles. In this reaction four neutrons are emitted. The new element was identified by its decay products. The decay sequence is $^{263}106 \xrightarrow{\alpha} {}^{259}\text{Rf} \xrightarrow{\alpha} {}^{255}\text{No} \xrightarrow{\alpha}$ (Rf is element 104— mitochondrion. and No is element 102—nobelium). The genetic linkage was established by specially designed apparatus in which ^{263}106 atoms were swept in a stream of helium gas to the surface of a wheel that could be rotated close to solid-state detectors in such a manner that the emitted alpha particles from ^{263}106, ^{259}Rf and ^{255}No could be recorded in their natural time sequence. The operation of the apparatus was controlled by a computer which also recorded on magnetic tape all the experimental data. A total of seventy three ^{263}106 emitted alpha particles and approximately the expected corresponding number of ^{259}Rf and ^{255}No alpha particles were recorded.

The Dubna Group, headed by G. N. Flerov and Yu. Ts. Oranessian produced the required heavy ions with a 310 cm heavy-ion cyclotron. They chose lead as the target and bombarded ^{207}Pb and ^{208}Pb with ^{54}Cr ions of 280 MeV energy and intensity 2×10^{11} ions per second. The result was a product that decays with a very short half-life of 7 milli-sec. They assigned it the structure $^{259}106$, suggesting reactions in which two or three neutrons are emitted: ^{207}Pb, (^{54}Cr, 2n) and ^{208}Pb (^{54}Cr, 3n). In the Dubna experiments the ^{54}Cr ions impinged on the lead target on the surface of a rotating disc. The product nuclei, decaying by spontaneous fission, were detected using dielectric mica detectors. A total of 51 spontaneous fission events were ascribed to $^{259}106$.

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Importance of sodium chloride

THERE is no inorganic compound which is taken as such in the human body except sodium chloride. Most foods are organic in form, but sodium chloride (NaCl)—the common table salt—is consumed as such by all human beings, rich or poor alike. The necessity and dietery importance of common salt can hardly be overemphasized because of its being a basic ingredient of our daily diet. The common salt is generally recognized as a stimulant. Anthropologists have pointed out that ancient civilizations developed in areas near either sea or dried up seas and lakes where good supplies of salts, particularly sodium chloride, were available.

Of more than 50 elements found in the human body, some are present in large quantities while others in small quantities. Sodium ions account for nearly 93% of the cations present in human blood and are taken primarily in the form of sodium chloride. Sodium is found mainly in the extracellular body fluids. Chloride is found largely in blood plasma and fluids outside cells of the body. When taken in small amounts, salt is immediately eliminated from the body through sweat and urine. But in larger doses, it is retained in body tissues and blood stream resulting in a state of hyperchloremia. In this condition salt in an above average amount circulates in blood stream. If there is rapid sweating, the amount of salt in blood is lowered, a state of hypochloremia follows and one starts feeling depressed.

Sodium helps in the regulation of acid-base equilibrium, cell permeability, in the maintenance of normal nerve irritability, water balance and osmotic pressure. When the human body contains abnormally large amounts of sodium ions it tends to retain water and a condition known as edema is obtained. Persons who develop edema are advised to reduce consumption of salt. Additional sodium may be needed following extensive loss of profuse sweating, recurrent vomiting, protracted diarrhoea, burns and a prolonged use of diuretics. Salt deficiency in the system produces symptoms like nausea, headache, dullness, anorexia (lack or loss of appetite for food), muscle weakness ,and in some cases mental confusion.

There are evidences of the effects of low as well as high intakes of common salt in both animals and men. It has been suggested that a high intake of common salt over a long period of time may cause a greater risk of hypertension. Sodium chloride has an important effect on the capillary activity and on the consumption of oxygen of the body. A healthy man kept on 15 g salt per day for 14 days showed an increased blood pressure, an increased basic metabolic rate and coarsened and thickened capillary walls. But when he was put on a diet poor in salt, i. e., 2 g per day, none of the above symptoms were observed.

An average adult consumes about 5g to 7g of salt in a day. However, this requirement may increase under those environmental and climatic conditions that cause increased sweating. Sodium ions are found in all body fluids and very little in the cells. On the other hand, there is relatively high concentration of potassium ions within the cells. Such a difference in concentration of sodium and potassium ions inside and outside the cells is vital to their functioning as is most readily seen in studies on highly irritable tissues such as muscle or nerve. When a nerve impulse passes, potassium ions flow out into the surrounding medium and sodium ions flow into the nerve cells. For another impulse to be conducted by that nerve cell, sodium ions must be pumped out, and potassium ions must enter. The whole process occurs in milliseconds.

Salt poisoning is very harmful and can be diagnosed only by careful chemical examination of secretions such as mucus, tears, gastric juice, urine, joint fluids, spinal fluid and blood. The best way to eliminate the deleterious effects of eating salt is to eliminate it from diet. Instead it can be eaten in organic form present in leaves and fruits. In organic form it is never so harmful. Some substitutes of NaCl such as monosodium or monopotassium glutamate are sold in the market, but they too have harmful effects.

It is thought that salt irritation of brain causes insanity. Salt can diffuse into cerebrospinal fluid and inflame the brain cells causing irritation and insanity.

Chloride is the principal anion of the body. No specific function of chlorine is known. Perhaps it is the most commonly available and convenient anion to balance the cations (sodium and potassium) in the body fluids. Though very little is known about the exact required quantity of sodium chloride in the diet, it is suggested that normal requirement is more than met from the food containing natural salt and the salt which is added to the food during cooking.

Sodium chloride provides a good example of difference between nutrition and stimulation. What constitutes nutrition may also destroy the vital organs causing permanent damage to the human body.

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Emulsions

In recent years emulsion technology has become an integral part of our life and industry. Various industries like paints, cosmetics, food, medicines, agricultural sprays, polishes, etc., depend on emulsion technology. No aspect of life remains untouched with this conspicuous colloidal system consisting of tiny droplets of one liquid dispersed into another. The commonest example is milk, the perfect food for infants.

Two immiscible liquids give rise to the formation of an emulsion. The two common types of emulsions are oil-in-water (o/w) and water-in-oil (w/o). Factors influencing these types of emulsions are the oil-water ratio and the stabilizer used.

From the thermodynamic point of view, emulsions are essentially unstable, they break up with time forming two distinct layers of the immiscible liquids. Spontaneous joining of tiny droplets in the emulsion to form bigger ones (coalescence) and resulting in two separate layers is termed as "Breaking" (Fig. 1). Creaming is a sedimentation process occurring due to the different densities of the dispersed and continuous phases. Flocculation is the process of aggregation or mutual sticking of droplets forming three-dimensional clusters without coalescence. An example of flocculation is the curdling of milk.

Emulsions are stabilized by certain surface-active agents called emulsifiers. They are adsorbed on the surface of the dispersed droplets forming a tough interfacial film resistant to flocculation and coalescence. Moreover, the dissociation of emulsifier into its ions induces similar charge on the droplets creating an electrostatic repulsive force between the tiny droplets which inhibits flocculation.

Emulsifiers exhibit high surface activity. Soap and detergents are the most efficient surfactants. They contain one or more hydrophobic groups (alkyl or aryl groups) along with one or more hydrophilic groups (anionic, cationic or non-ionic) within the same molecule. Such molecules are strongly adsorbed or oriented at an oil/water interface and form fairly persistant emulsions. Certain macromolecular substances like proteins, gums, starches, and polymers, also act as efficient emulsifying agents.

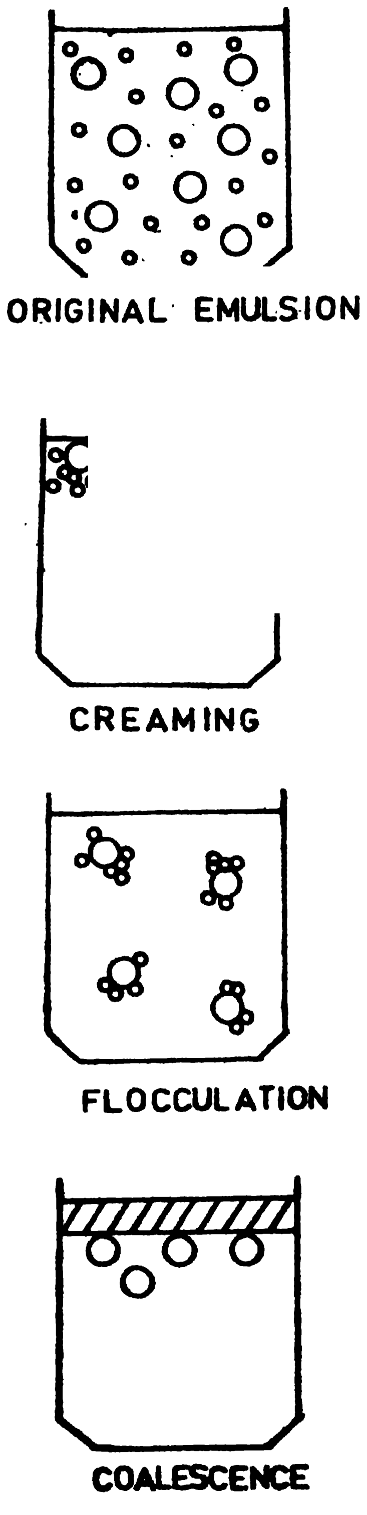

Fig. 1. Schematic representation of types of instability in emulsions

Emulsion applications

Emulsions play a very significant role in our daily life and industry. They are found in cosmetics, paints, polishes, agricultural sprays, food emulsions, medical emulsions, etc. The entire cosmetic industry centres around emulsion technology. The use of emulsions in lotions, vanishing and cold creams, for example, increases their penetration into the skin. Additional advantages of emulsions in cosmetics are economy, ease of application and efficient cleansing action. Apart from beauty lotions and various creams, deodorants and hair shampoos also form part of cosmetic industry involving the use of oil/water emulsions.

Cold creams are cosmetic emulsions of high oil content. They were originally w/o emulsions but are now being replaced by o/w emulsions. The cooling sensation, characteristic of cold creams, occurs due to the fact that the emulsion breaks on being rubbed into the skin liberating water whose evaporation has the desired effect. The vanishing creams are of the similar type but with lower oil content and contain a small quantity of a strongly hydrophilic compound (e.g., glycerine) to increase penetration. Even more dilute o/w emulsions are employed as hand lotions, facial milk, etc.

Food emulsions. The most important field of emulsion technology involves food preparations. Some of the familiar emulsions known to man are butter, salad dressings, etc. Mayonnaise is essentially an o/w emulsion of edible vegetable oil, egg yolk and vinegar with the addition of salt, sugar and dextrose. The high stability of this food emulsion is attributed to the presence of egg yolk which contains lecithin and cholesterol as emulsifiers. Similarly, the salad dressing is also an o/w emulsion largely stabilized by egg yolk. Ice cream is an emulsion of butter fat, non-fatty milk solid, air and water. At low temperatures, the stability of the emulsion is greater due to the increased viscosity.

The use of emulsifying agents in baking is widespread. For example, the cake has a tendency to produce excessive shrinkage or falls too much on being removed from the oven. The addition of mono or diglycerides of polyglycerols improves the quality of the cake and imparts to it greater resistance to shrinkage.

Emulsion paints. An emulsion paint may be considered as a relatively simple system consisting of a vehicle (the liquid phase) and pigments, which impart colour and opacity to the painted suface. To this may be added a volatile thinner which makes application easier. Emulsion paints have certain advantages over water and oil paints. In some recent formulations of such paints, synthetic resin emulsion is used in the vehicle, the synthetic high polymer constituting, in whole or part, the "oil" phase.

Polishes are oil or wax emulsions in water which breakdown when applied to a sufrace. On breaking down, the glaze imparting ingredient spreads over the surface making it smooth and glossy.

The use of chemicals as insecticides, pesticides and weed killers has long been in vogue. Agricultural sprays are usually sold as 'emulsifiable concentrates' which are solutions of toxicants in organic solvents to which is added an oil-soluble emulsifier. For use, water is added to the concentrate and the desired emulsion is prepared by shaking. Insecticide emulsion, when sprayed over plants, breaks down to deposit on the plant body a film of toxic agents that lasts quite long.

Medicines administered in the form of emulsions are easily absorbed by the human system and have a lasting effect.

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Lithium and mental diseases

ALTHOUGH lithium was introduced in medicine over a hundred years ago for the treatment of diseases like gout, rheumatic disorders, and urinary calculi (small stones formed in the urinary tract) its unique psychoactive potentiality (as lithium carbonate) in manic excitement was discovered in 1949 by an Australian scientist J. G. J. Cade (*Med. J. Aust.*, 36, 349-352). In recent years this simple inorganic salt has brought about a revolution in psychopharmacology (a discipline that deals with the mechanism of action of several psychoactive drugs), both because of its use in the treatment of mania and the promise it holds as a prophylactic agent in preventing recurrences of affective illness, a condition with a disturbance of mood either in the direction of mental depression or elation.

The three monoamines that have received most attention in the brain function are noradrenaline, dopamine and serotonin. Chemical and

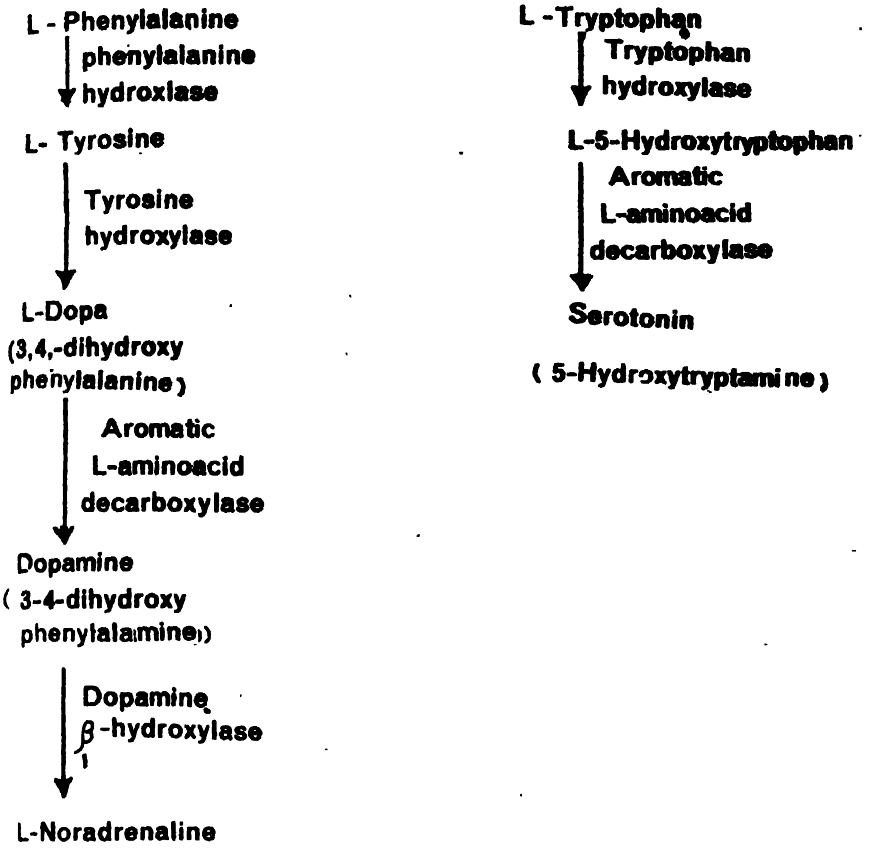

Fig. 1. Biosynthetic pathways for noradrenaline, dopamine and serotonin

biological studies indicate that these substances are located in certain nerve cells and nerve-endings. The most likely function of monoamines in specific regions of the central nervous system (CNS) is as chemical transmitters between nerve cells, or as modulators of transmission by other substances (such as acetylcholine). Catecholamines (collective term for noradrenaline, dopamine, etc.) are synthesised from the plasma amino-acids, L-tyrosine or L-phenylalanine.

The mechanism by which lithium exerts its effect on mania and depression is not yet clear. Most studies exploring the mode of action of lithium have centered round the role of monoamines in mental disorders; the second area has been the effects of lithium on body electrolytes. It has been proposed that during depressions a relative deficiency of noradrenaline occurs at crucial receptor sites in the brain, resulting in excessive mania. It has also been suggested that there exists a similar abnormality in serotonin metabolism. The mode of action of lithium may fit into catecholamine hypothesis of affective disorders which states that elation may be associated with increased levels of catecholamines, particularly noradrenaline. And, conversely, depression may be associated with the depletion of these monoamines at the critically effective adrenergic receptor sites in the brain.

Clinical reports on lithium suggest that there is a triphasic pattern of water and electrolyte response. First, lithium causes a marked increase in the urinary excretion of water and sodium, and perhaps potassium and calcium too. Second, there is compensatory retention of sodium in depression and excretion during mania. Third, there is return to a stable normal state. Further, it has been shown that the monoamine uptake into the cell is dependent upon sodium and potassium gradients across the cell membrane. A defect in the sodium pump mechanism would lead to an alteration in the sodium balance and a disorganisation of monoamine uptake and synthesis within the cell. A differential effect between the two monoamine groups could be expected. For example, noradrenaline is dependent on calcium concentration for release, whereas calcium does not appear to affect serotonin release. Studies also show sodium retention in depression and its excretion during mania. It has also been found that the intracellular to extracellular lithium ratio is stable for normal individuals but may vary with behavioural changes. Lithium has also been shown to have potassium-like effect on brain respiration, i.e., it causes an increase in oxygen consumption and metabolism.

The therapeutic dose of lithium carbonate varies with individuals, and must be determined in each case by a series of estimations of the plasma or serum lithium concentration. Ordinarily lithium treatment is started at about 600-900 mg per day, reaching a level of 1200-1800 mg per day on the second day. Subsequent doses are adjusted according to the patient's clinical condition. Overdosage gives rise to a variety of toxic effects, like anorexia, transient gastric discomfort, vomiting, diarrhoea, thirst, hand tremor, slurred speech, blurring of vision, dizziness, confusion, etc. Thus it is important to establish a specific diagnosis before lithium treatment. During the treatment plasma lithium levels should be

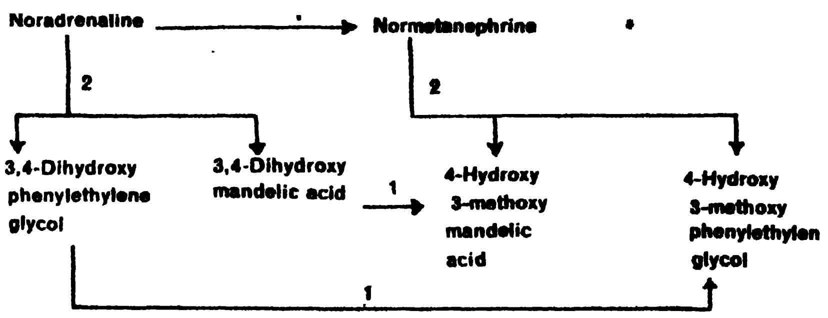
Noradrenaline
Normetanephrine
2
2
3,4-Dihydroxy phenylethylene glycol
3,4-Dihydroxy mandelic acid
1
4-Hydroxy 3-methoxy mandelic acid
4-Hydroxy 3-methoxy phenylethylen glycol
1

Fig. 2. Noradrenaline catabolism pathways

checked every 3 or 4 days to avoid risk of intoxication.

Lithium is excreted in faeces, sputum, sperm and sweat, but mainly in urine. In man, the highest excretion occurs about one and a half hours after ingestion. The pattern of lithium excretion and retention in normal subjects remains constant. The retention level depends on the dose; low lithium doses for prolonged periods does not cause the same retention as with higher doses for shorter periods.

Lithium is readily absorbed from all the standard routes of administration, viz., oral, subcutaneous, intramuscular and intraperitoneal, and it is not bound to plasma proteins. The oral route is the one adopted in clinical studies in man. Lithium passes from the bloodstream and an equilibrium is established between serum and cells in some tissues such as liver, kidney, spleen, muscle, bone and brain. Analysis of tissues from animals and man after prolonged lithium treatment gives no indication that lithium is accumulated to considerable amount in any specific organs.

Conclusion

When first introduced into psychiatry lithium was condemned as dangerous. Now after twenty-five years it is hailed as a panacea for many forms of mental illness, and is becoming a treatment fashion and fad. Right at this moment it is safe to conclude that lithium is an effective agent for the manic phase of manic-depressive illness. It seems, therefore, that the possibility of using the etiology of manic-depressive illness is perhaps the most exciting aspect of its introduction into psychopharmacology.

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Manganese in drinking water

IT is said that metal pollution is worse than nuclear radiation risk, even though the latter has received greater publicity. Some of the metals found in water are mercury, cadmium, lead, arsenic and manganese. The first four elements are not usually found in natural waters. They find access to water sources as a result of man-made pollution.

Manganese, usually associated with iron, occurs but rarely in natural water, especially in acid mine waters and occasionally in ground and surface waters. It occurs as manganous sulphate and bicarbonate in acid mine waters, as bicarbonate in ground water and as a bicarbonate and organic (chelated) manganese in surface waters.

The W.H.O has prescribed 0.1 mg/litre of manganese as the permissible limit in water for drinking purposes. The standards are more rigorous for waters for industrial use, especially for paper, textiles, dyeing, synthetic fibres, etc.

Manganese as a trace element to some extent is essential for animals. This is mainly derived from foods and not from water. Manganese in excess can cause intoxication, sometimes with fatal results. In a small town near Tokyo, Japan, in 1942 there was an outbreak of an encephalitis-like disease. The affected persons got their water from three of the five wells in the area. Analysis revealed that the water in these three wells contained large amounts of zinc and manganese. Water from the other two wells did not contain these metals. Examination of the surroundings revealed that over 400 dry battery cells (which contain manganese dioxide as a depolariser) were buried within 0.9 to 2.7 metres of these wells. Urine and blood samples of the intoxicated persons contained large amounts of manganese and zinc, so also the viscera of three fatal cases. Zinc however did not seem to have any deleterious effect.

Manganese in amounts 0.2-0.4 mg/litre can bring in complaints regarding taste. In this range it can cause stains on washed and cooked vegetables. Clothes washed in this water may also be stained. Manganese at these levels can also cause serious trouble in the water treatment plants and the distribution system. Mannese bacteria, called the *Manga- se crenothrix*, derive their energy om the oxidation of manganous mpounds into insoluble manganese ioxide. Unless the element is re- oved from raw water, manganese ioxide clogs filters reducing their ficiency. These bacteria can also rive in the dark and adhere the inner surface of the pipes. hey often get loose and block the ains, meters, nozzles and taps. ne bacterium can oxidise upto 00 times its weight of a manganous ompound.

Methods of removal of manga- ese are the same as for iron. An crease in the pH of water or xidation by chlorine or ozone elps remove manganese completely. arious other methods employed or the purpose are; (a): aeration, ettling and filtration, (b) sodium ation exchange, (c) hydrogen cation xchange process, (d) lime soda sof- ening, and (e) manganese zeolite rocess.

As there is a constant increase in population, collection and proper disposal of solid wastes should be planned. In the U. S. A. an analysis of solid wastes from municipal areas has shown that they contained nearly 7% to 8% of metals on a dry weight basis. Solid wastes in India may also contain considerable amounts of metals. Most of our municipalities dispose off solid wastes by open dumping. Fermentation in the presence of organic wastes may lead to formation of humic, acetic, oxalic, and formic acids. The latter may react with metals to form salts or chelates which may in turn slowly percolate and contaminate groundwater. On the other hand, in course of time, the demand for these metals may offset their production. It is therefore advisable to explore ways for their economic reclamation and reuse.

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A food poison effective only in sunlight

ABALONE, also called ear-shell because of its shape, is a mollusc with a greatly flattened shell which, like the limpet, fails to cover the whole body. The outer surface of the shell is covered by a rough, horny coating over which there is usually a profuse growth of algae and bryozoa. But the inner lining of the shell has a beautiful pearly iridescence. Before the advent of plastics, the ear-shell was extensively used for mother-of-pearl buttons, brooches and trinkets.

The abalone is provided with a powerful set of muscles by means of which the animal clings to the rocky surface of sea-shore. The large muscle is quite tasty, and the animal is an esteemed sea-food in the preparation of soup, steak or chowder. The animal moves slowly with a clumsy, swinging motion. It can be easily picked up when caught unawares, but once it is frightened and sticks to the rock, a great deal of force is required to detach it. Some species of abalone grow to over 30 centimetres (a foot).

The ear-shell (*Haliotis*) is found in the Indian Ocean, extending up to Australia and Japan. It also occurs on the west coast of U. S. A. as well as in Africa and Europe. Usually only the muscle is eaten, but in oriental countries the entire animal, including the viscera, is consumed. In certain seasons this leads to a peculiar type of poisoning. The poison is believed to have its origin in the food, mainly sea-weeds which the animal eats.

In case of abalone poisoning there is a sudden burning and stinging sensation on the body, followed by a reaction similar to urticaria, viz., prickling sensation and itching, oedema (swelling) and erythema (reddening of skin), followed by skin ulceration. The peculiarity of this illness is that these lesions on the skin are limited only to those parts of the body which are exposed to sunlight; there is a distinct boundary between the bare and the covered portions of the body. In fact, abalone viscera poisoning is a rare instance of dietary photo-sensitization, induced by a food of animal origin. The poisoning has been found to be due to the ingestion of the digestive gland (liver) of the animal.

The illness is not restricted to humans. When laboratory animals, such as cats, rats and mice were fed *Haliotis* liver, no appreciable symptoms were seen when these animals were kept in the dark. When brought out into sunlight, however, there was a dramatic response. Starting with erythema and pruritus within a few seconds of exposure to sunlight, the animals became irritable, scratching and rubbing the skin. There were swellings on parts of the skin not covered by fur. This was soon followed by increased lachrymation (tears- and salivation, intermittent convul) sions, paralysis followed by death within half an hour. The animals recovered somewhat when brought back to the dark but had loss of

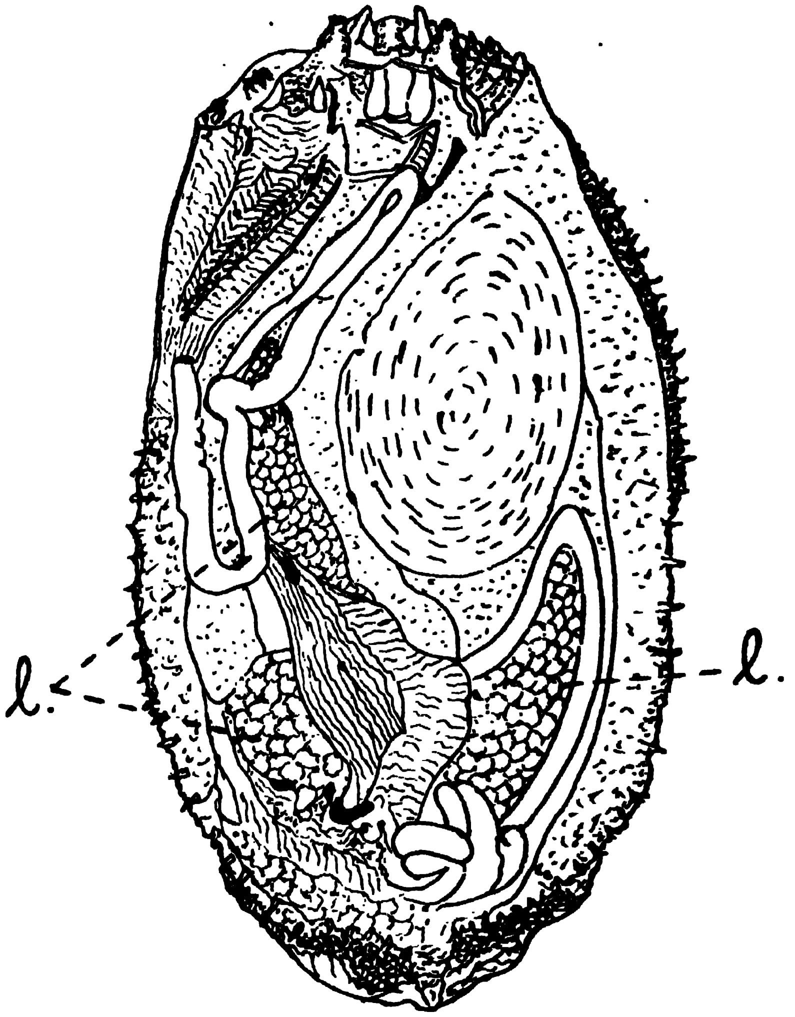

Fig. 1. Dissected abalone showing the (l)

appetite and weight, and the body temperature was low. The swelling subsided after a few days, but necrosis (decay) developed on the ears, head and back. After three weeks the skin in these regions sloughed off. The naked skin areas subsequently developed a new growth of hair. *Haliotis* liver at a dose exceeding 5 grams per 100 gram-weight of the test animal was sufficient to cause the symptoms.

The toxic principle in the liver of *Haliotis* is stable even after boiling for half an hour or after cold storage (– 15° to –20°C) for ten months. It is insoluble in water, but dissolves in organic solvents such as methanol, ethanol, acetone, ether, chloroform and acetic acid. Liver extracts in these solvents appear dark brownish-green and show intense red fluorescence under ultra violet light or sunlight. It is a chlorophyll derivative, as indicated by positive Molisch test, and has an intact isocyclic ring.

How does one avoid the unpleasantness of this illness? The best way is to eat only the flesh of the abalone, rejecting the viscera, especially the digestive gland. If one insists on consuming the entire animal, however, one will have to stay in the dark for some time thereafter!

Finally, a few words in favour of the ear-shell. Extracts prepared from the animal have indicated the presence of antibacterial and antiviral substances; they inhibit several gram positive as well as gram negative bacteria, influenza 'A' and polyoma virsuses. *Haliotis* may, therefore, yield a powerful anti-biotic too!

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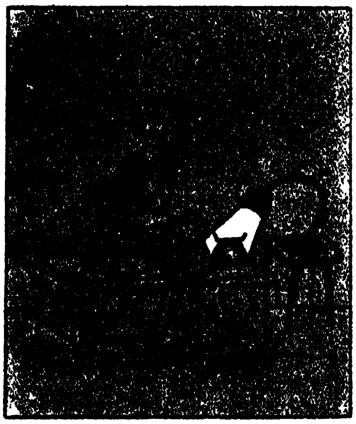

"I'm afraid I shall not be able to come for tomorrow's picnic on the beach. We had abalone liver for dinner tonight."

Photorespiration

T has been known for a long time that light exerts considerable effect on respiration in plants. This is possibly due to a secondary process of photorespiration, which may be much more intense in some plants than in others. G. Krotkov and his coworkers at Kingston, Canada, observed that respiratory CO_2 evolution is 3 to 5 times higher in the light than in darkness and that there is a post-illumination burst of CO_2 output, especially at higher oxygen concentrations. In 1963, he introduced the term "photorespiration" to differentiate between these apparently separate forms of CO_2 evolution. Photorespiration appears to be maximal in low ambient CO_2 concentration, high O_2 concentration and high temperature·

While evolution of CO_2 is increased in light, oxygen causes a depression of net photosynthesis. The reduction of photosynthesis by atmospheric oxygen was first noticed by O. Warburg, a German scientist, as early as in 1920 and is known as "Warburg effect".

In 1970, Martin Gibbs of U. S. A. observed that glycolate synthesis is enhanced by oxygen. Thus the photorespiratory release of CO_2 is believed to be closely associated with the metabolism of glycolate, a 2-C acid. Israel Zelitch (1974) of New Haven, U. S. A., showed that inhibition of glycolate synthesis in tobacco leaf discs is accompanied by a decrease in the amount of photorespired CO_2 and increase in net CO_2 fixation.

Although glycolate is formed within the chloroplasts, it cannot be further metabolized in chloroplasts. This is due to the fact that chloroplasts do not possess the enzyme glycolate oxidase required for glycolate oxidation. Further degradation of glycolate has been found to take place in a newly discovered cell organelle called "peroxisome" which contains this enzyme abundantly.

Site of photorespiration

Photorespiration or glycolate metabolism involves three cell organelles, viz., chloroplast, peroxisome and mitochondrion. But the major site of reactions is in the peroxisome. Peroxisomes are microbodies which are found as subcellular organelles in a wide variety of biological tissues. Biochemical studies carried out by C. De Duve of Belgium and coworkers (1966-1969) have shown that these organelles contain flavin-linked oxidases that produce hydrogen peroxide in liver and kidney cells. The enzyme catalase, which breaks H_2O_2 into $H_2O + \frac{1}{2}O_2$, has also been detected in them. He termed these particles as "peroxisomes" to emphasize their role in hydrogen peroxide metabolism.

N. E. Tolbert (1968-1971) of the Biochemistry Department, Michigan State University, U. S. A, and his associates have investigated microbodies in leaves and called them leaf peroxisomes because they appear similar in many respects to liver peroxisomes. These microbodies range in size from 0.2 to 1.5 microns in diameter and are characterized by a single limiting membrane, a granular matrix and often a dense core or a crystalline inclusion. The microbodies can be isolated from cells by 'sucrose gradient' technique.

Microbodies and mitochondria are two different types of subcellular particles for respiration, but they are readily distinguishable because of their entirely different composition and function. Mitochondrial respiration conserves biochemical energy as ATP, whereas microbody respiration is characterized by flavin oxidases and hydrogen peroxide generation.

Mechanism of photorespiration (Glycolate pathway)

Leaf peroxisomes have been found in photosynthetic tissues of all higher plants, and contain most of the enzymes for the glycolate pathway. The mechanism of glycolate biosynthesis and the nature of the reactions by which it is metabolised with the associated release of CO_2 are still subjects of conjecture. Several schemes have been suggested (Fig 1.)

P-glycolate is produced in an oxygen-dependent reaction catalysed by RuDP carboxylase. The formation of glycolate from P-glycolate is mediated by the enzyme P-glycolate phosphatase contained in chloroplasts. The oxygenase activity of RuDP-carboxylase has been observed in *Chromatium*, *Rhodospirillium*, *Chlorella* and spinach. The oxygen promotion of photorespiration can be explained by the facts that RuDP-carboxylase activity is inhibited by oxygen and its oxygenase activity is increased by high oxygen concentration; and that the photosynthetic oxygen is not sufficient for glycolate oxidation. The oxygenase activity is also increased by low CO_2 concentration because it inhibits the oxygenase activity. High temperature accelerates the oxygenase activity more than the carboxylase activity. These observations offer possible explanations for the increased photorespiration seen with higher oxygen or lower CO_2 levels or higher temperature. Inhibition of photosynthesis by oxygen (Warburg effect) is, however, relieved with low concentration of ribose-5-phosphate or fructose-1-6- diphosphate but glycolate production remains unaffected in isolated chloroplasts. This suggests that glycolate formation is not a causal factor of Warburg effect. Temperature optima for photorespiration and Warburg effect are also different.

There may be several pathways for further metabolism of glyoxylate. Three decarboxylation pathways in photorespiration have been proposed: (i) in the mitochondrion, (ii) in chloroplast itself, and (iii) in peroxisome. The most widely accepted pathway involves the conversion of glyoxylate to glycine which is then transferred to mitochondrion. In

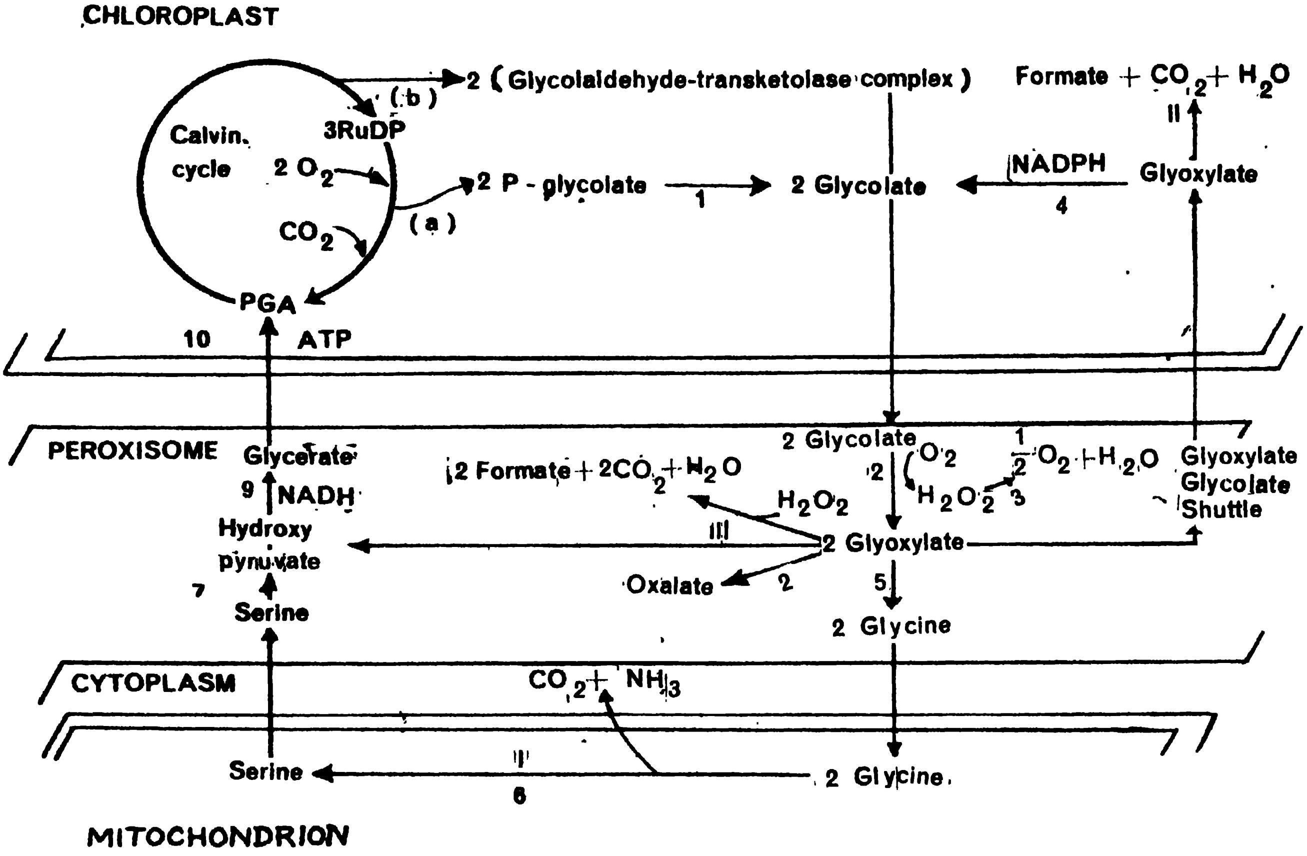

Fig. 1

the mitochondrion two molecules of glycine are converted into one molecule of serine and one of CO_2, which escapes in the cytoplasm. An alternative proposal for glycolate metabolism has been advanced by I. Zelitch (1972) of U.S.A. It states that glyoxylate formed from glycolate oxidation in peroxisomes can be returned to chloroplast and then photo-oxidised (with H_2O_2 as probable oxidant) and decarboxylated to formate and CO_2. Similar peroxidation may also take place in peroxisomes (B. Halliwell and V. S. Butt, 1974). This is more attractive since minimum transfer of metabolites between organelles is necessary. Glycolate metabolism in *Chlorella* and *Anabaena* is different from that in higher plants. In these algae conversion of glycine into serine in mitochondrion has been found to be associated with increase in ATP synthesis. This has led to the proposal of existence of a light-dependent synthesis of ATP in mitochondria.

The serine formed in mitochondrion is returned to peroxisome again and converted into glycerate via hydroxypyruvate. Glycerate formed is presumably transferred to chloroplasts and phosphorylated to PGA by glycerate kinase and ATP (Fig.1).

Significance of photorespiration

In an illuminated leaf, there are two opposing processes: photosynthesis consuming CO_2 and photorespiration generating CO_2. About 50 per cent or more of the CO_2 fixed during photosynthesis subsequently can be evolved via glycolate pathway as photorespiratory CO_2. This means that all the fixed CO_2 would be subsequently photorespired and the plant would cease to grow. It is, however, believed that the amount of RuDP carboxylated in air is at least 4-5 times that oxidised and in that case less than 20 per cent of the fixed CO_2 would be lost due to photorespiration. This discrepancy points to the fact that alternative pathways of glycolate synthesis and metabolism exist.

Photorespiration must be considered as more than simply an addendum photosynthesis. Some researchers believe photorespiration is a metabolic adjunct to the Calvin cycle. Since oxidation of glycolate is not coupled to ATP synthesis, this process of photorespiration seems doubly wasteful. Why such an apparently wasteful process exists in plants at all is still a puzzling question. Though the positive function of photorespiration remains unknown, the possibilities that it contributes to amino acid biosynthesis, disposal of excess reducing power, and removal of H_2O_2 have been considered by some. To these can be added the possibility of light-dependent ATP synthesis in mitochondria. The fact that plants free of photorespiration have not been found suggests that the process is essential; but it is puzzling why some plants have more of it than others.

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Genetic basis of baldness

A young man may feel himself proud of having thick, dark hair on his head when he finds that one of his friends has lost almost all the hair from his head. Commonly we see that only men are bald. However, bald women are not uncommon. The advantage of females over males in this case is that the genetic mechanism operating in the former helps them to hide it out.

Several environmental factors are often mentioned as possible causes of baldness. Infectious diseases such as syphilis and specific abnormalities of thyroid metabolism may cause baldness. Exposure to high energy radiations may also cause loss of hair in both sexes. But the most common, premature or "pattern baldness", occurs in healthy individuals. Studies on distribution of the character in many family groups exhibit that the character is transmitted from parents to their sons and daughters. A hereditary basis for baldness is therefore possible. The hereditary basis of baldness was indicated long ago by Greek philosophers. Hippocrates, the father of medicine, drew attention to the recurrence of baldheadedness in certain family groups.

Apparently it seems that baldness is a recessive, sex-linked character like colour blindness, because it occurs more frequently in males than in females. One of the characteristics of sex-linked inheritance is the absence of male-to-male, that is, father-to-son transmission. But bald fathers often transmit the character to about half of their sons and to a few of their daughters. So, the inheritance of baldness does not follow the pattern of sex-linked genes. Investigations on the mode of inheritance of this trait, however, revealed that it is controlled by autosomal genes (genes situated on chromosomes other than sex chromosomes) known as sex-influenced genes. Sex-influenced genes are those whose dominant expression depends on the sex of the individual, that is, sex of an individual exerts influence on the expression of these genes.

As an explanation of baldness it has been suggested that an allele (one of the two alternative forms of a gene) H^N in homozygous condition (H^NH^N, that is, when the two members of a given pair of alleles are identical) results in normal hair growth in both men and women. Another allele H^B in homozygous condition (H^BH^B) produces baldness irrespective of sex of the individuals. H^B in heterozygous condition ($H^N H^B$), however, is dominant in a male but recessive in a female, that is, males H^NH^B heterozygotes are bald but females are normal (Fig. 1). A man, therefore, is bald if he has only one gene for baldness (H^B), whereas a women must possess two such genes to become bald. This dominant gene can express itself only in the presence of an adequate level of androgenic hormone (male sex hormone). All normal men and women possess sex hormones in their bodies. Males have androgens (or masculinizing hormones) and females have estrogens (feminizing hormones). A male also produces a small amount of estrogen in his body. Similarly, in a female, androgen is produced by the adrenal cortex (the outer part of the adrenal glands). The ovary also produces traces of androgen. Quantitively, however, females have less androgens than males. The level of the male hormone necessary for the expression of baldness is reached in all normal men but rarely in women. This accounts for the higher incidence of baldness in males than in females.

Some geneticists, however, have suggested that baldness is not actually a sex-influenced but a sex-limited trait (that is, genes responsible for this character are expressed only in one of the two sexes). According

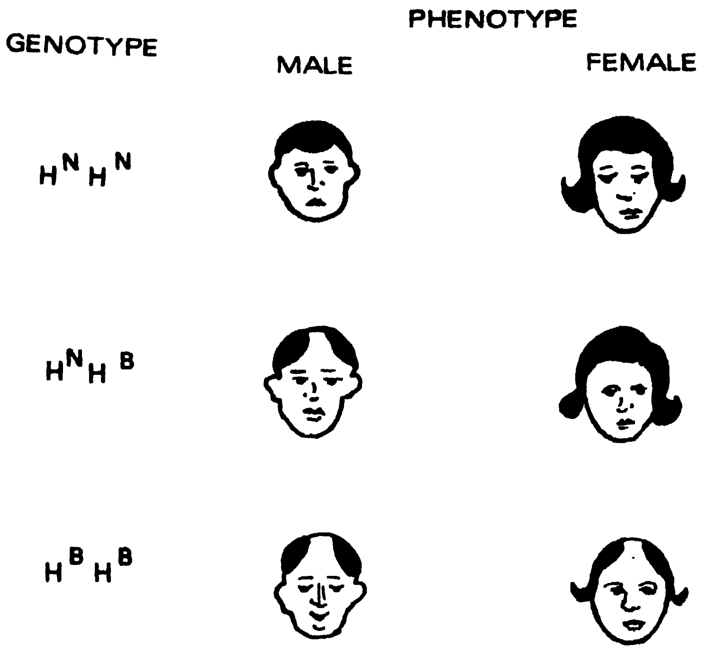

Fig. 1. Baldness in human males and females: genotypes and the corresponding phenotypes

to this view, baldness, like the development of beards and moustaches, is a male-limited trait and remains unexpressed in all women having normal levels of sex hormones in their body. Occasionally females become bald if they produce a masculinizing hormone in their body. If the quantity of this hormone reaches a particular level, the genes for baldness can act and result in baldness.

The phenotypic expression of baldness varies from one person to another. Baldness may be slight or extreme, develop on the forehead or on the tophead and may appear early or late in life. Some persons become bald prematurely, before the age of thirty and others develop it later.

If a man, heterozygous for baldness ($H^N H^B$), marries a normal woman ($H^N H^N$), about half of their sons may be expected to become bald but all their daughters will have normal hair. On the contrary, when a bald woman ($H^B H^B$) marries a normal man ($H^N H^N$), all their sons are expected to be bald but all the daughters will be normal. If both parents are bald, all their children may be bald, or all sons and some daughters are affected.

So, if a man begins to lose hair from his head, he may consult a physician. Hair growth may be restored if the cause is environmental or physiological. If the cause is genetic, there seems to be no remedy.

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Hedgehog and toad poison

THE use of poisons and toxic substances on the tip of arrows and other sharp weapons is an old practice that has been followed by primitive man for ages. Even now, tribals and aborigines in many parts of the world use this method. Their main purpose is obviously to make the weapon—arrow or spear—more effective in killing or maiming the victim. In a recent issue of *Nature* (268,627, 1977), an American biologist, Edmund Brodie, reports about a similar use of poisonous substances by hedgehogs, the insectivorous animals with sharp spines on the back. These animals roll into a spiny ball when frightened, an action which normally turns the attacker away Brodie observed that hedgehogs use toad skin poison to anoint their own spines, possibly as an added protection against predators.

Toads (*Bufo*) are normally found in natural habitats of the hedgehog and are commonly eaten by the latter. When hedgehogs attack toads, they first bite and chew the parotid glands (which contain the greatest concentration of skin toxins), and

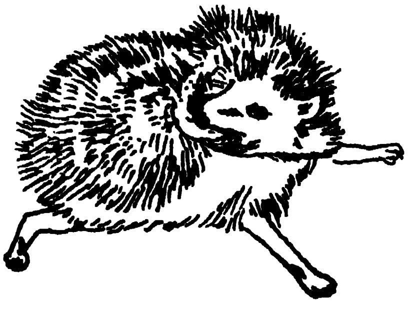


Fig. 1. Adult hedgehog anointing its spines with the froth of saliva and toad skin secretion after chewing a toad

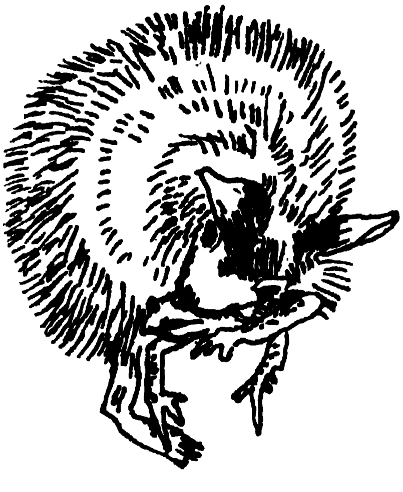


Fig. 2. A hedgehog rubbing a whole toad (*Bufo*) against its spines

then spread the resultant frothy mixture of the toxin and saliva oxer the spines (Fig. 1). Sometimes the hedgehog holds the toad in its mouth and rubs its skin over the spines (Fig. 2). Young hedgehogs have been observed to lick the frothy mixture from their mother's spines and apply it to their own.

In tests with volunteers, it was found that the toxin-coated spines produced immediate intense local burning sensation when jabbed into the skin. Uncoated spines caused no pain other than the mechanical pain of puncture.

Biman Basu

Echolocation in animals

All animals have their own signals for communication with other members of the group. A particular type of acoustic signal is associated with a particular type of action. For example, the sound made during courtship differs from that made in anger or in response to an enemy. Most of these sounds are audible because we can hear sounds between the frequency range of 30 cycles per second to 20,000 cycles per second. Certain animals use sounds of higher frequency (which are inaudible to us) for locating objects. For this the animal emits sound waves which are reflected when they strike an obstacle. The animal hears the sound waves reflected from the object and is able to judge its distance. This phenomenon of locating objects from the echo of the sound reflected from an object is known as 'Echolocation'.

Echolocation has been observed in some crustaceans and insects, and in many fishes, birds, bats and whales. In most cases this fascinating activity is not aided by an animal's visual sense. Echolocation has however attained perfection in just two animals—bats and dolphins. Bats deserve more credit for their historic significance, for the impetus that they have given to this branch of study.

Aquatic echolocation

Contrary to the well-known saying, "silent as a fish" fishes are not all that silent. We do not hear the noises of fish and other animals under water because most part of the sound is reflected back from the surface into water and hardly any reaches our ears.

Object location in arthropods (animals with jointed appendages) by echo-sounding is not acoustic but is connected with a tactile sense. However, there is a certain analogy between this system and one of the true acoustic nature.

Sound orientation in *Mixodiaptomus laciniatus*, a fresh water crustacea, has been proposed by many authorities. Sound is produced by the swimming actions of the animal and the receptive centre for the echo seems to be located in the first pair of antenna on its head.

The freshwater beetle *Gyrinus* 'whirls' on the water surface to survey the water. The sound produced by its swimming movements is reflected from obstacles and picked up by its elaborate antennae which form a fringe of sensory hairs on a pedicel. Its ability to avoid obstacles is far less skilful in distilled water, while it is enhanced in stagnant water covered by dust particles and thin films of oily substances.

Several 'Echo fishes' have been discovered in the ocean. Echos are of the order of 500 c/s. In contrast to birds and mammals, where variations in pitch play an important role, the different pitches (or spectral composition) of the sounds in fishes remain constant and only the rhythm is variable. However, in minnows, the spectrum ranges from 85 c/s to 11,000 c/s.

All sound-producing organs found so far in fishes are more of

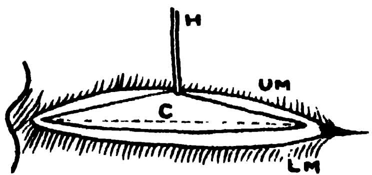
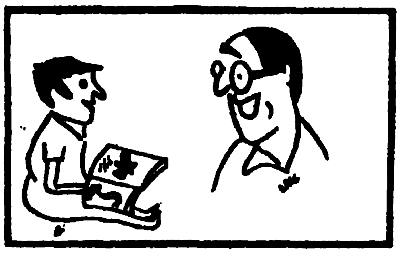


Fig. 1. Membranes covering one side of the laryngeal cavity of the bat *Eptesicus fuscus*. C-cavity; H-hook holding up the upper membrane (UM); LM-lower membrane



"Daddy, snakes hear through eyes and bats have vision through their ears?" "The former is a saying dear, but the latter is echolocation."

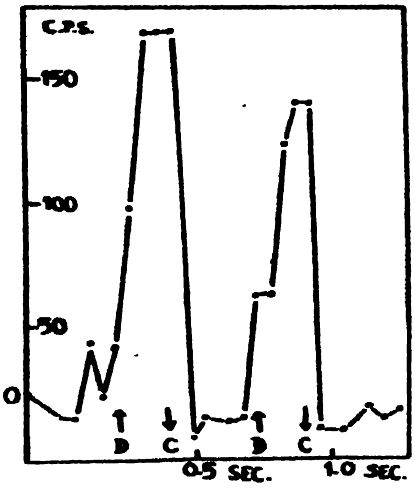


Fig. 2. Rate of emission of the orientation sounds of a *Myotis* species when flying in search of prey. C-catching a prey; D-detection of a prey; O-the ground

the nature of 'percussion instruments'—instruments where sound is produced by strikings or collisions. The swim bladder in fishes is an apparatus of hydrostatic function, i.e., it helps the fish to maintain equilibrium while the latter orients itself at different depths inside water. In some fishes it acts as a resonator, apparently involved in both the transmission and reception of sound signals. Various forms of drum muscles are attached to the outside of the swim bladder which make it vibrate.

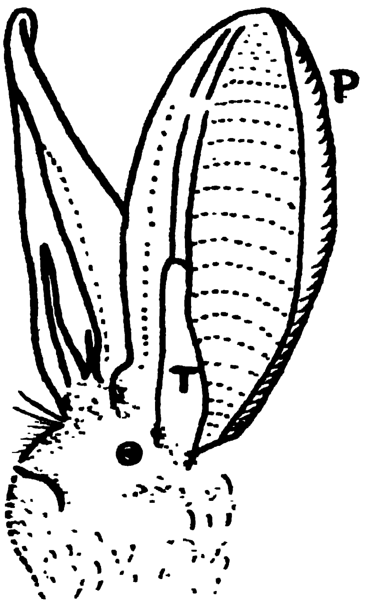


Fig. 3. Head of the l[illegible] eared bat *Plecotus auritus*. P-[illegible]na; T-tragus.

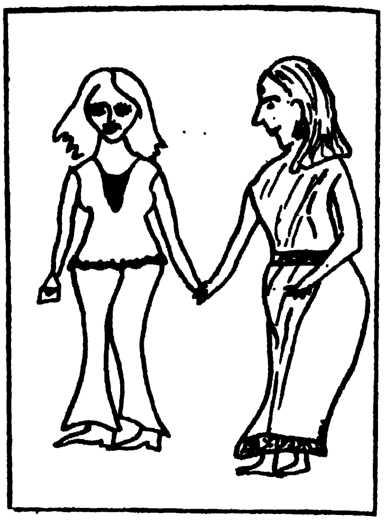
Whales and dolphins, apart from possessing a conversational sound vocabulary, make cries which are evidently intended for echolocation. However, in "dolphin territories" the dolphins can swim very fast silently as they are well used to it. Dolphins can swim at speeds greater than 38 km per hour, and locate objects up to 36 m away, even in turbid water, through echolocation.

A controversy remains as to how the cetaceans produce sounds in the absence of true vocal cords. Some investigators think that they use their nostrils and air sacs of the respiratory tube; others are of the opinion that the throat (special growths of the inner wall of the larynx) is used. However, the cetaceans, more specially odontoceti, have well developed auditory organs of great sensitivity and can locate the source in water in a way humans do in the air.

Aerial echolocation

The moth, *Prodentia evidania*, in addition to the fundamental frequency of the wing beats, which is too low to stimulate tympanic organ, emits a pulse with a frequency close to 15 kc/s. This is usually meant for echolocation.

The 'oil bird' or guacharo (*Startonis*) is a cave dweller of Peru, Venezuela, Guyana and Trinidad Island. It displays a double system of orientation, both visual and acoustic. The acoustic orientation is apparently utilized in the dark. These sounds have a frequency range of 6.1 kc/s to 8.75 kc/s and each click lasts for 1 m /sec . to 1.5m/sec. The clicks are not emitted regularly, but in 'bursts'.



"The other day when there was a load-shedding I was trying to echolocate him but I located my mummy instead."

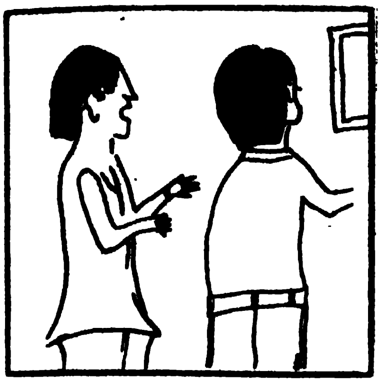
The Salariganes (*Collocalia*), birds of South Asia, emit clicks whose purpose, nature and duration are similar to those of *Startonis*. However, the clicks become more intense when the bird flies towards the darkest part of the cave but they virtually stop as it flies towards light.

Other birds like swifts of Europe and the common night hawks echolocate their insect prey by emitting sounds composed of a series of short pulses.

Rats probe their environment by emitting acoustic signals. When they do not hear an echo, they know the presence of a hole in front. The squeals of laboratory rats, *Rattus norvegicus*, cover frequencies from 19 kc/s to 29 kc/s which last for two seconds. Similar ultrasonic components upto 54 kc/s have been recorded in the squeals of guinea pigs, *Cavia cobaya*, but their whistles are within the audible range.

Bats were the first animals to attract attention of scientists to the existence of echolocation. Different kinds of bats use different mechanisms of echolocation.

The source of the emitted sound in bats is located in the respiratory



"How is that you don't get caught by your parents while talking to her through this window?"
We communicate through inaudible ultrasounds.

tract. The rhinolophid bats (horseshoe bats) emit and control the focus of the sound through the nasal folds and thus have the advantage of feeding without any disruption in ultra-sound production. In the vespertilionid bats the sound emitted is partly vocal and partly nasal. To avoid confusion, the ear is plugged with a muscle just at the time a cry is produced.

Analysis shows that bats make three kinds of noises—first, an audible cry at a frequency of about 7,000 c/s; secondly, a supersonic cry which is loudest at 45,000 c/s to 55,000 c/s; and thirdly, an inaudible click. The second is actually responsible for the bat's ability to locate obstacles.

The intensity of the echo is much lower than that of the original sound because of spreading loss and physical absorption in the air. But bats can evaluate an echo even if the sound pressure is reduced by 1/1000th part of the original signal. Moreover, according to 'Doppler-Fizeau Effect', a sound appears to have a slightly higher frequency to a listener moving towards the sound-reflecting surface. Bats measure the distance to an object in terms of the time lag between their outgoing orientation sounds and the returning echo, both of which are coded in terms of neuro-responses.

Bats can pass through passages far narrower than any birds of the same wing-spread can get through. They can skilfully avoid wires of 1 mm in diameter hung vertically at 30 cm intervals in a room. Certain fish-eating bats echolocate fish close to the surface. Echolocation aids a great deal in bat's homing habit.

In spite of their wonderful feat of echolocation, bats at times do make errors when they are tired or are not fully awakened, or are careless and over confident. Protective behaviour of insects (camouflage within thick hairy covering to absorb the ultra-sound and preventing echo production or by developing ultra-sensitive hearing organ) and confusing elements like echoes from the surrounding objects, cries of other bats and ultrasonic pulses generated by insects also add to errors in echolocation in bats. Laboratory experiments have however shownthat jamming the bat's sonar system isextremely difficult.

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Mystery of dinosaur plates

Of all the reptiles who ruled the earth through one hundred million years of mesozoic history, stegosaurs or plated dinosaurs were perhaps the strongest in appearance. Being one of the earliest members of the known ornithischian reptiles (a primitive reptilian stock), stegosaurs were remarkable for a number of peculiar features of their own which were not shared by any other members of the group. These so-called 'double-brained' creatures were distinguishable from their close relatives by the presence of a series of raised plate-like structures on the dorsal side of the body (Fig. 1). For the last several years, both biologists and paleontologists have been trying to establish different physiological aspects of the now extinct stegosaurs. The study of the morphology and the preserved arrangement has indicated that in living condition the plates of stegosaurs stood upright near the dorsal midline of the body; the edges of the plates were thin but the bases were thick and embedded in the back. It has also been suspected from the fossil remains, that in living animals these plates were covered by a thin horny layer. It is, however, interesting that incontrast to the usual bilateral symmetry of reptiles, the dorsal plates of stegosaurs were arranged in an alternating or staggered manner instead of being paired. On the tail, on the other hand, there were four long pointed bony spikes which, unlike the dorsal plates, were typically paired and symmetrical in arrangement (Fig. 1). There is a general agreement among the paleontologists and biologists regarding the function of the tail spikes as an organ of offense, but the function of the dorsal plates is still a matter of dispute.

C.W. Gilmour of the National Museum of United States regards

these plates as additional defensive devices used to threaten enemies. Dr. L. Davitashvili of the USSR Academy of Sciences, Moscow however discards the idea of Gilmour and advocates that the plates of stegosaurs were actually used for sexual display during courtship and reproduction.

A group of American biologists, Drs. James Farlow, Carl Thompson and Daniel Rosener of Yale University, USA, have suggested in a recent communication (*Science* **192**, 1123, 1976) that the plates of stegosaurs were actually used as fins to radiate body heat. The arrangement, size, shape and the nature of probable vascularity of these plates suggest for them an important thermoregulatory function. Wind tunnel experiments, internal heat conduction calculations and direct analysis of the morphology and anatomical features of dorsal plates also clearly indicate the effectiveness of the plates as heat dissipaters. It has also been revealed from other experimental studies that the capacity of heat dissipation was controlled through input blood flow rate, temperature and body orientation of the animal with respect to the wind.

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LETTERS (*Continued from page 616*)

folia, 3.04 mm for Poplar and 8.87 mm for Chir.

However, further experiments are being conducted at the F.R.I. to study the water consumption behaviour of *E. tereticornis*. Also, a 5th Five-Year Plan scheme to establish four Environmental Research Stations at Srinagar (J & K), Simla (H.P.), Kurseong (W.B.) and Ootacamund (T.N.) has been sanctioned. These research stations would *inter alia*, study the effect of forest cover on ground water supplies. All these studies would in due course dispel the doubts regarding the suitability of the species.

Chif Publicity & Literature Officer
FRI & Colleges
Dehra Dun

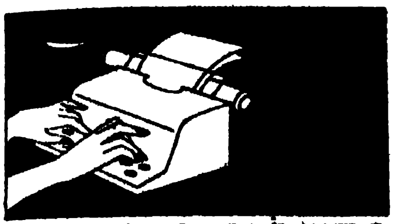
ORIGIN OF LIFE (*Continued from page 620*)

cause it is "a classic viewpoint but one which is far from satisfactory for numerous biologists". All the more so, because Schoffeniel's book provides none which is more satisfactory. All in all, it seems to me that Schoffeniel's denigration of Monod's "classic" viewpoint is like Don Quixote's tilts at the windmills. They do not hurt the windmills but they do amuse the onlooker no end.

Further reading

1. Monod, Jaques, *Chance and Necessity*, Vintage Books, New York.

2. Schoffeniels, E., *Anti-Chance: A Reply to Monod's Chance and Necessity*, Pergamon Press, Oxford, U.K.



NEWS & NOTES

Prof A. V. Hill —a tribute

PROFESSOR Archibald Vivian Hill, who died on June 3 this year at the age of 90, was described by *The Times* as "One of the foremost scientists of his time." The first scientist from Britain to have been awarded the Nobel Prize in Physiology and Medicine in the year 1923, along with Otto Meyerhof, Professor Hill is known primarily as a biologist. But few know that he was a multi-faceted genius equally at home with mathematics or physical chemistry or instrument design. Professor Hill was by no means a cloistered scholar or a narrow specialist. A man of wide interests, Prof. Hill was a Member of Parliament from the University of Cambridge, an adviser to the Government on subjects as diverse as medical education and defence from air-attack, and was "a fine athelete, a genial host and a convincing speaker and writer."

Born on September 26, 1886, he went to Trinity College, Cambridge in 1905 and won the 3rd Wrangler position in the Tripos of 1907. Then he faced the problem of choosing his field, whether to pursue further study in mathematics or to turn to another subject where he could utilise his thorough mathematical training.

Taking the advice of his tutor Sir Walter Fletcher, Hill decided to shift his interest from mathematics to physiology. But he did not sacrifice mathematics, instead, after obtaining a First in the Natural Sciences Tripos in 1910, he tried to combine the two. He turned to "various problems in physiology which seemed ripe for mathematical treatment."

His beginning with a modification of Nernst's theory of excitation established him as a mathematician ready to consider the problems of experimental biology. In fact, this field was very much in need of a person with a solid foundation in mathematics. As per the suggestion of Langley, a Professor of Physiology, Hill took up the programme "to investigate the phenomenon of heat production of muscles during activity". After visiting several laboratories in Germany where muscle physiology was being studied, he returned in 1911 to begin research on heat evolution in muscle and nerve, his most important work that earned him the Nobel Prize and immortalised his name in the annals of biological sciences.

With the help of extremely sensitive instruments he succeeded in the difficult task "to separate the different phases in the energy cycle of muscular contraction and to relate them to the chemical events, some of which had been studied in Cambridge by Hopkins and Fletcher". But measuring a scientist of Hill's stature by this work alone would be unjust. In fact, Professor Hill's contribution to the development of biology was tremendous and this was so because his researches clearly showed how much could be gained with the proper use of techniques and concepts of the more exact sciences.

Though Hill was, in a sense, a public man by virtue of his holding important positions on national and international committees, his output in research was simply prolific and there is no denying the fact that his leadership in organising scientific research "helped to establish the subject of biophysics as ripe for development, with important aims and a territory of its own."

During the First World War, Hill led the team which studied scientifically the anti-aircraft gunnery and this early exposure to the field of operational research stood him in good stead and equipped him better in introducing scientific techniques during the Second World War. After the First World War, Hill was appointed Professor of Physiology at Manchester and in 1923 as Professor at University College, London. He became Foulerton Professor of the Royal Society in 1926 and remained in that chair for about quarter of a century before he retired in 1951.

An Editor of the distinguished *Journal of Physiology*, Professor Hill became the Secretary of Royal Society. He had been for five years (1940-1945) a Member of Parliament from the University of Cambridge. An Independent Conservative in the House of Commons, Prof. Hill could impress all and sundry by his sincerity and expert knowledge. In order to reorganise his laboratory he retired from Parliament which was very much regretted. But his laboratory was soon re-established as a major centre of biophysical research, attracting some of the finest young talents from all over the world.

Prof. Hill spent his whole life fighting for his cause—science and scientists. His uncommon common sense and a truly liberal outlook made him the fittest person for heading scientific communities dealing with national and international problems. His role in rescuing scientists, persecuted for their race or opinions, in Germany would be remembered for long. As Foreign Secretary of the Royal Society and Secretary-General of the Council of Scientific Unions, Prof. Hill rendered yeoman service in reviving scientific activity in Europe after the Second World War. An Honorary Fellow of King's College and of Trinity College, Cambridge, and honoured all over the world, Professor Hill was President of the British Association in 1952.

Known as "AV" to his colleagues and friends, Professor Hill was a gentle, warm person. He married Margaret Keynes, sister of the famous economist, Lord Keynes, in 1913. A well-wisher of India, Professor Hill was indeed a citizen of the world and his death symbolised the death of a scientist who was more than just a scientist.

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An Interview

Dr. U.R. Ghatak

Dr. Ghatak

"IN our country, a researcher carries forth his work only because of his aptitude for research. Otherwise, other prospects of his life are not that attractive," says Dr. Usha Ranjan Ghatak, the 1974 S.S. Bhatnagar Award winner in Chemical Sciences. He is very much correct, though on the face of it it may not look apparent. To put it frankly, this is one reason why our country produces time and again some brilliant scientists while the average level of scientific temper remains the same low. That also explains why there are only a few pockets of research institutes and schools where brilliant work is on. Those who are totally dedicated and fortuitously get proper guidance and facilities go ahead, while others vegetate.

Still, according to Dr. Ghatak, "most of our younger scientists are doing what they could. But to maintain a high standard of research it is necessary to have the minimal facilities. Otherwise, one loses in the international competition only because of dearth of resources. There is, then, all the greater need for a hard competition between researchers in the country."

Born on February 26, 1931, in Brahmanbaria (now Bangla Desh), Dr. Ghatak's early life was one of struggle and hardship. During his college days he had to earn for his education and maintenance either through private tuition or part-time teaching. In 1947 after Bengal partition, his family migrated to Calcutta where he did his B.Sc. (Hons) and M.Sc. In 1957 he did Ph.D. from the Indian Association for the Cultivation of Science, Calcutta, and since then he has been working there. He has done research at various foreign universities and is also a visiting scientist.

Dr. Ghatak has made outstanding contribution to methods for stereochemically controlled organic synthesis, particularly in fields of complex diterpenoids and bridged-ring polycyclic compounds. These compounds are related to some physiologically active natural products such as the important plant growth regulating hormones—gibberellins and the tri-and pentacyclic diterpene alkaloids. An interesting bridged-ring hydrocarbon has also been synthesised by his group which shows a strong pheromone activity towards *Rhinoceros* beetle, a pest of coconut palm, in olfactometer tests.

His work has led to a deeper understanding of conformational and steric factors of organic molecules which control bond formations in organic synthesis. It has also focussed on new reactions that form such bonds in novel ways. Many of the methodologies developed in his work have both academic and applied interest.

Dilip M. Salwi

All India Seminar on Ichthyology

THE first All India Seminar on Ichthyology (AISI) was held from May 23 to 26, 1977 at Zoology Research Laboratories, M.M. College, Meerut, under the auspices of University Grants Commission. Seventy four ichthyologists from different states attended the seminar.

Dr. A. G. K. Menon, President, Ichthyological Society of India and Deputy Director, Zoological Survey of India, Madras, expressed the need of fundamental knowledge of taxonomy for the young ichthyologists of the country. He proposed to provide facilities of training programmes, and workshops in taxonomy at the Zoological Survey of India, Madras. Dr. V. P. Agarwal, Principal, DAV College, Muzaffarnagar emphasized the necessity of fish research, pertinent to the immediate requirements of the masses and maintained that there should be a dynamic coordination between scientists and industrialists.

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Symposium on Ion-Exchange

The Central Salt and Marine Chemicals Research Institute, Bhavnagar, is organizing a symposium on Ion-Exchange in Feb. 1978. It will be a two-day symposium and will include about 8 topics covering a wide range of interests in ion-exchange. For details, write to Dr. D. R. Baxi/Dr. G. T. Gadre, Secretaries, Symposium on Ion-exchange, Central Salt & Marine Chemicals Research Institute, Bhavnagar-364002, Gujarat.

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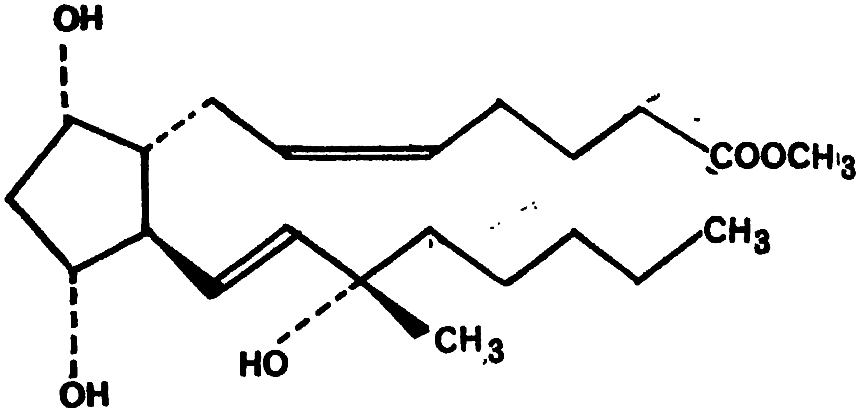
Solution to crossword puzzle published in *S.R.*, September 77

MEDICAL NOTES



A new drug for abortion

FAMILY welfare and family planning departments throughout the world have been in frantic search of a safe and effective drug capable of causing smoother termination of unwanted pregnancies. But so far there has been little success. A group of six Swedish doctors, headed by Dr. M. Bygdeman of the Department of Obstetrics and Gynecology, Karolinska Hospital, Stockholm (Sweden), has recently announced a discovery which may revolutionise abortion. In a report, published in 1976 they say that a vaginal device containing 15(S) 15-methyl-PGF$_{2\alpha}$ methyl ester when applied to women even in an advanced stage of pregnancy, resulted in successful abortion; and bleeding started within hours of the drug application.

Prostaglandins are the factors which stimulate smooth muscle and reduced blood pressure. In a slow releasing vaginal device, Dr. Bygdeman's group administered the drug to 30 women in the 1st and 2nd trimester (3-months period) of pregnancy. Ten of them were in the early stages (31-49 days following the last menstrual period) and the other 20 in the 10th to 20th week of pregnancy. The results were compared with those given repeated vaginal administration of triglyceride suppositories containing prostaglandin—50 patients in early pregnancy and 30 patients in the 2nd trimester of pregnancy.

The total mean dose of the prostaglandin given to these two groups was 3.9 and 7.8 mg respectively. All the 60 early pregnant patients aborted following the treatment. Bleeding started in 3 to 6 hours following the start of treatment and continued for 10-14 days. In only two patients the abortion was found to be incomplete. The side effects in some of the women were comparable to those following the use of repeated vaginal suppositories. In all the three groups of patients in the late 1st and 2nd trimester of pregnancy; treatment resulted in abortion within 24 hours in 90% of the women. In all the three groups of patients the side effects were within acceptable and safe levels. It is hoped that further development of the device may result in an effective vaginal administration treatment for the quick and smoother termination of both 1st and 2nd trimester pregnancies.

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Butylated hydroxy toluene is linked to tumour

BUTYLATE hydroxy toluene (BHT) is a preservative used for nearly 30 years in foods. Now evidence has come up to show that it causes tumours and other problems in test animals. The Center for Science in the Public interest in the U.S.A. is campaigning for its immediate ban because of safety questions, and of its unnecessary addition as a preservative in foods. Americans each year consume about a million pounds of BHT, which was approved by the U.S. Food and Drug Administration (FDA) for use in foods in 1954. It is used to retard rancidity. Its heaviest use is in fats and oils followed by jams and jellies, sweet sauce, nut products, milk foods, soft candy, baked goods, confectionery, frosting, gelatin puddings, frozen dairy products, gravies, alcoholic beverages, chewing gum, soups, processed vegetables, processed fruits, nonalcoholic beverages and hard candy. FDA earlier this year proposed that BHT be dropped from the approved list of food additives but be allowed until further conclusive studies.

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FOR HER

Caesarean babies and lung diseases

THERE has been a significant increase in doctor-caused lung disorders among new borns because obstetricians are performing too many caesarean operations. The number has risen astronomically, with caesareans accounting for more than 20 per cent of all deliveries in some hospitals, reported Dr. L. Gluck, Head of Neonatal and Perinatal Medicine at the University of California Medical Centre in San Diego .

A caesarean operation involves the removal of an unborn baby from the uterus by a surgical incision through the abdominal wall. The ill-advised timing of caesarean operations is threatening to become the leading cause of respiratory distress syndrome (RDS) or hyaline membrane disease in infants. Both of these lung disorders are fatal and often leave the infant with permanent lung damage. The problem has arisen by the widespread use of new foetal monitoring equipment. Using sensors attached to the unborn infant, this equipment is intended to detect foetuses that run into serious troubles inside the uterus. Usually when oxygen supply to foetus is cut off, a caesarean operation can often save it. Some physicians are, however, using the foetal heart-monitoring equipment without knowing how to interpret the information. They misinterpret readings and order a caesarean when it is not needed. When this happens, an infant may be removed from the uterus too early when his lungs are still premature. Such a stress can cause lung disorders. In America, caesarean operations nearly doubled from 1967, when they accounted for 5.1 per cent of all deliveries, through 1974 when the rate rose to 9.8% according to the commission on Professional & Hospital Activities in Ann Arbor, Michigan. Studies show that 9 per cent of the infants born through caesarean operations have premature lungs, compared to a premature lung rate of 6-7 per cent for normal deliveries.

Caesarean operations have become excessive in some hospitals. A report claims rates as high as 26 per cent. Hasty caesareans can be avoided with proper tests to measure the maturity of the infant's lungs while it is still in the uterus. These tests measure chemicals, such as lecithin and sphingomyelin, which increase as lungs mature.

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What's a shampoo ?

THE use of shampoos has changed over the years as totally as their composition. Formerly soap was used for washing the hair, today it is shampoo. In initial stages shampoos were made of soaps or mixture of soaps, whereas today synthetic detergents are mostly used in their preparation.

R. G. Harry, an English cosmetologist, defines shampoo as "preparation of a surfactant (i.e., surface-active material) in a suitable form—liquid, solid or powder—which when used under the conditions specified will remove surface grease, dirt and skin debris from the hair shaft and scalp without affecting adversely the hair scalp of health of the user." Scientists have observed that a good shampoo should cleanse hair and scalp thoroughly without stinging or irritation, and should not remove too much of the natural oil from the scalp. A shampoo is not only a detergent but a cosmetic as well, and it must impart lustre, beauty and manageability to hair.

Types

Shampoos are classified according to their appearance, or in some cases, their special ingredients or properties. They may be of the following types (i) Liquid clear, (ii) Liquid cream or cream lotion, (iii) Cream paste, (iv) Egg, (v) Herbal, (vi) Dry, (vii) Liquid dry, (viii) Colour, and (ix) Aerosol.

In addition, one or several of these types may be based on special raw materials or have special additives that would make them antiseptic or antidandruff.

Raw materials

Soaps are generally considered as the salts of fatty acids. They are mostly made from animal and vegetable fats and oils. Oils which contain primarily the shorter chain fatty acids yield better foaming soaps. These shorter chain acids contain 10 to 12 carbon atoms in a straight chain and usually work best at low temperatures. The soaps from fatty acids with somewhat longer chains (13 to 15 carbon atoms) are excellent cleaners, particularly in warm water and those from long chain fatty acids (16 to 18 carbon atoms) are most effective at 70 °C and higher.

The vegetable oils are glycerides of fatty acids, ranging from caproic, with six carbon atoms, to behenic with 22 carbon atoms in the chain. In fatty acids with less than 10 carbon atoms in the chain, salts too are soluble to show an appreciable detergency, while the soaps of fatty acids with more than 20 carbon atoms are too insoluble to act effectively at normal temperature.

Olive oil soaps have long been considered the best for shampoos. As the soap made from olive oil is essentially sodium oleate, such a shampoo is not good for lather formation. In many olive oil shampoos some free oil is left in the shampoo to contribute a conditioning effect to the hair.

Soaps from coconut oils have always been noted for their excellent lather. They consist chiefly of sodium laurate and sodium myristate. Some claim that soaps from coconut oil are more drying and that they may be irritating to the skin, perhaps due to their caprylic and capric acids content.

The shampoo obtained from a single fatty acid is rarely satisfactory. A good shampoo requires a number of properties and no single acid contributes the wide range of characteristics needed. In recent years, triethanolamine soaps have come into popular use.

Shampoo additives

An increasing number of compounds have been developed which are not in themselves shampoos but which contribute to the performance or acceptance of shampoos. They may contribute to the foam, feel, consistency or finish imparted by the shampoo.

Finishing agents. The difference between an ordinary detergent and a shampoo lies in the finishing action of a shampoo. Finishing agents have been of great importance in increasing the use and acceptance of synthetic shampoos. In the early soap shampoos, the unsaponified vegetable oils contributed to conditioning action. More recently, lanolin and its derivatives have been promoted as finishing agents in spite of the fact that they cut foaming and scouring action. Mineral oil is used only occasionally as it is difficult to wash it out from hair. Esters such as isopropyl myristate and butyl palmitate, and particularly the mono and diethanolamides of fatty acids are used as finishing agents.

Conditioning agents. Finishing agents and conditioning agents are closely related. Glycerol, propylene glycol, sorbitol and urea help retain moisture and delay its evaporation. Their addition in shampoo formulation softens the hair and helps retain moisture in them.

Preservatives

Then there is the problem of protecting the shampoo from deterioration by bacterial or mold action. This necessitates the selection of a preservative from formaldehyde, methyl , propyl or butylhydroxy benzoates, alkyl anisoles, hydroxyquinolene, dehydro acetic acid salts and alkyl cresols.

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SCIENCE FOR THE YOUNG

Birds and bird-song

NEXT to human beings, birds are the only vertebrates which make a variety of sounds and sing songs. Other vertebrates, such as mammals, reptiles, fishes and amphibians are generally silent. The tiger can only roar; some snakes can hiss; frogs and toads can make noise during breeding season and a few fishes can grunt. Most invertebrates, say, insects, are instrumentalist in that they produce sound by rubbing together modified appendages of the body. These vocal or non-vocal sounds do not, however, equal the melodious songs of the birds.

As in humans, so in birds, all sounds are not songs. The vocal sounds made by birds are classified as songs and call-notes depending on the length and function. According to W.H.Thorpe (1956), "a bird's call-note, in contrast to its song, is a brief sound with a relatively simple acoustic structure."

Call-notes indicate alarm, anxiety, warning, intimidation and greeting. For instance, the quail uses a special note as a gathering call when the members of the covey are scattered. Similarly, the young of birds make distinctive food calls when hungry and quite different calls when adequately fed.

Many definitions of bird songs have been given, but recent knowledge of bird behaviour proves that these definitions are either too restrictive or too broad. The bird song has been defined by Saunders (1929) as "a vocal performance usually confined to the male and to a definite season of the year; that season includies the time of courtship and mating". A song is not necessarily musical nor is it always confined to the male. For example, when the common pigeon (*Columbia leavia*) dances in front of its 'sweet heart' and utters very unmusical "gootre-goo, gootre-goo", the call may be defined as a song because the behaviour shows that the male is trying to entice the female. It has been repeatedly proved that most, if not all, birds sing to attract the opposite sex, or to defend their territory. That is why songs reach their highest intensity during the breeding season.

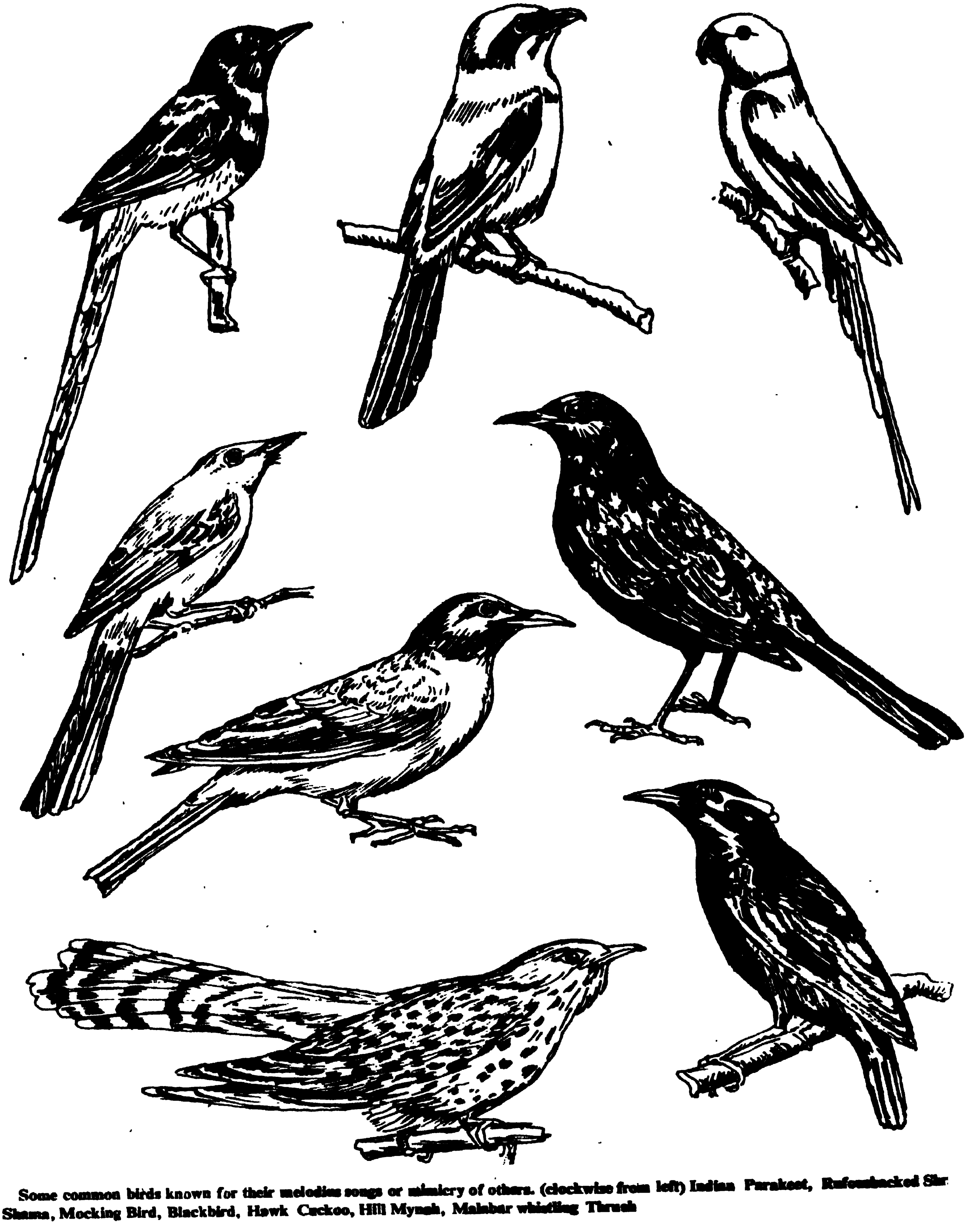
Bird songs serve many functions and express a variety of emotions. They are classified as territorial or advertising songs, signal songs and emotional songs. The territorial song is related to territoriality in birds, and according to Josselyn Van Tyne (1959), "it is one of the biological isolating mechanisms that guarantees the mating of individuals belonging to the same species."

In almost all cases it is the male who sings territorial songs. The sound signifies he has a territory and that other males of the same species should not trespass his 'home'. Other equally important role of this song is to attract the mate. For example, in the snow bunting (*Plectrophenax nivalis*), Tinbergen (1938) noted that the mated male abruptly stops singing, but any threat to the male's territory, or the loss of the mate, causes him to renew singing. Many birds such as robin, bulbul, sparrow, weaver bird, etc., which raise two or three broods every year, intensify their singing before every mating. That is why we hear songs throughout the breeding season. While one bulbul may be silent feeding the young, another may be singing and attracting his mate for the beginning of second or third brood.

The function of the second category—the signal song—is to coordinate the activities of birds, particularly the mated pair. In some birds the signal song may be same as the territorial song, only the function differs. In such cases, the signal songs may be an integral part of courtship behaviour.

Duet or antiphonal singing of birds is unique in the animal kingdom. In many species of birds found in dense tropical forests, the notes of the male and female, which are at some distance apart, are different. The two sexes sing antiphonally. This is the way of informing a bird the whereabouts of its mate.

In antiphonal singing, one mate sings a few notes to be taken up by the other. For example, in the magpie lark of Australia, one bird calls "te-he" and the other quickly replies "pee-o-wit". Some birds



Some common birds known for their melodies songs or mimicry of others. (clockwise from left) Indian Parakeet, Rufousbacked Shr Shama, Mocking Bird, Blackbird, Hawk Cuckoo, Hill Mynah, Malabar whistling Thrush

synchronize so perfectly that unless both partners are in view, it is impossible to know that more than one is singing.

The songs which are neither territorial nor signal are classified as emotional types. The idea that birds sing for the fun of it is perhaps not entirely baseless. Everybody knows that young energetic boys and girls frequently burst into song when they are happy. Similarly, in birds emotional singing is a normal outlet of excess energy. In listening to the melodious song of *shama* (*Copsychus malabaricus*), one gets the impression that the bird is enjoying itself.

Mimicry

Another unique vocal development in birds is mimicry. Some birds such as the shrikes (*Laniidae*), bower-bird (*Ptilonorhynchidae*), mocking bird (*Mimidae*), parrots (*Psittacidae*) and hill myna (*Gracula religioso*) not only sing songs of their own species but perfectly imitate notes and songs of other species. The most skilled and persistent mimics are the bower-birds of Australia. The spotted bower-bird is credited with mimicking the sound of thunder, barking of dogs, the noise of cattle moving through bush, the croaking of frogs, honking of cars and weeping of a child! There are few sounds they cannot produce. In our country the Rufous-backed shrike (*Lanius schach*), is supposed to be the best mimic. According to Dr. Salim Ali (1961), "it is a very accomplished mimic, quick at learning and with a retentive memory. Harsh squeals of a frog caught by snake, yelps of newly born puppy, tame grey partridge's call prefaced by its human owner's whistles, and calls of numerous birds even long after many have migrated, are imitated to perfection". So next time if you hear the plaintive metallic "Piu-piu-pee-pee-piu...pee-piu-piu" of the pied crested cuckoo (*Clamator jacobinus*) at a time when the cuckoos have long since left off calling or have migrated, look for this shrike.

In all languages, the popular names of some birds are based on the onomatopoeic words from their calls. For instance, the call of the Hoopoe (*Upupa epops*), is a loud "hoo-poo" or "hud-hud", repeated two or three times, which has given rise to the names current in various languages—all onomatopoeic in origin. No doubt the above mentioned bird is called *Hudhud* in Hindi and it is known as Hoopoed. in English ·

The call of a bird is interpreted differently in different languages. A common cockerel may seem to say "cock-a-doodle-do" to an Englishman, but a German thinks it says "kikerike" and a Japanese hears it as "kookke-kokke". Each can hear only the phonetic sound of his own language. Another example is of the call of the common hawk-cuckoo or brain-fever bird (*Caculus varius*). The loud screaming song of this bird sounds as "brain-fever" to an Englishman, while a Hindi speaking person may hear it as "pee-kahan?" (Where is my love?). A Marathi may interpret it as "paos-ala" (Rain is coming).

The call-note of the once widespread black partridge (*Francolinus francolinus*) is a loud and grating cry of several syllables. The high pitched "chick-cheek-cheek-keray" is rendered by the devoted Muslims as "Subhan-teri-qudrat" (O Omnipotent, thy power). The sport-loving people take it as "noon-piyaz-adrak" and infer from it that the bird should be prepared with salt, onion and ginger.

Legends of bird songs

Many legends have originated from the songs of birds. It is popularly believed in the peasant community that the pea-fowl (*Pavo cristatus*), our national bird, heralds the coming of rains by its loud trumpet-like scream "minh-aao" (Come rain). The peacock is very noisy during the monsoon months, especially on cloudy days. Topoor farmer for whom untimely rain may make a difference between starvation and plenty, the call of the peacock represents his inner prayer to the rain-god. The peacock was thus venerated and protected even before it was declared a national bird.

The tales of unfulfilled love and grief-stricken lovers arouse interest in all societies. Our folklore is also full of such stories and many legends are based on bird calls. For example, the Great Himalayan barbet (*Megalaima virens*) utters monotonous, mournful cry, "peee-oh", "meee-oh". The bird sits high up in some shady tree and owing to the green colour of its plumage and ventriloquil song becomes difficult to locate. The inhabitants say that the bird is the reincarnation of the soul of a suitor who died in grief at the unjust termination of his love. He is therefore proclaiming to the world "un-nee-ow, un-nee-ow"—injustice, injustice.

The beautiful surkhab (*Todorna ferruginea*), famous for its feathers, has an unhappy story woven around its voice, (Whistler, 1935). In vernacular language the surkhab or the Brahminy duck is called *Chakwa-Chakwi*. It breeds in Ladakh and Tibet, but during winter migrates to plains and it is generally found on the sand-banks of rivers. They live in pairs or small parties. At night they feed on vegetable matter, molluscs, aquatic insects, fishes and reptiles. While engrossed in feeding the pair often gets separated and calls each other. This has given rise to the legend that the surkhab have the souls of erring lovers, who were doomed to remain within sight and hearing but separated by the flowing stream. The nasal conversational call "aang-aang" of the pair is rendered to form the names of *Chakwa* and *Chakwi*. The Chakwi asks "Chakwa-a-unga" (Chakwa, I will come). The Chakwa sadly replies "Chakwi-na-aoo" (Chakwi, do not come).

According to Dr. Salim Ali (1961) the most accomplished songster of our country is the greywinged blackbird (*Turdus boulboul*) of the Himalayas; the Malabar whistling thrush (*Myiophoneus horsfieldii*) and the the Shama (*Copsychus malabaricus*) come next in order.

The Malabar whistling thrush is very restless, always flitting through the trees or feeding on an open hill stream. During breeding season, which is from February to August, the male sings a musical whistling song. The bird is partial to well-wooded hill streams of the Western Ghats, Madhya Pradesh and Orissa. As it sings aimlessly up and down the scale, it is known as the "Whistling-schoolboy" in the Nilgiris.

Bird-watching is a fascinating hobby. It becomes more interesting when we start interpreting the songs--scientifically or mythologically. The villagers sometimes tell amusing tales concerning the call of birds. While I was bird-watching in Kukrail near Lucknow, a villager told me that the Dumri or the Common Babbler (*Turdoides caudatus*), which lives in flocks of a dozen birds, is altruistic in its behaviour. Every bird constantly advises the other "Tohee-peeo, tohee-khayoo" (You drink, you eat).

There are thousands of legends related to birds song. If, instead of killing them, people start observing and recording bird-life, our literature will be greatly enriched.

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How a stethoscope works

HAVE you ever wondered what the doctor hears when he conducts a physical examination of a person with a medical instrument called stethoscope? The stethoscope has derived its name from two Greek words meaning "chest observer", because it was first used in detecting some chest disorders. Rène Laènnec (1781-1826), a French physician, is credited with inventing the stethoscope in 1816.

Heart is a muscle which expands and contracts regularly, pumping the blood around the body. It occasionally produces a sound beat or vibration that may sound 'lub-dub-shish' or 'lub-shish-dub' which travels through bones, muscles and other tissues of the body. This low pitched sound produced in lungs or beating heart is too faint and is beyond the hearing capacity of a person. The stethoscope is a simple device for picking up sounds and vibrations (e.g., heart-beat, pulse-beat, etc.) made by various organs of the human body. The sound waves enter the hollow tube in which they are successively reflected from its side walls. This phenomenon is known as 'multiple reflection' of sound. The stethoscope then amplifies and concentrates the sound in one direction by the method of 'multiple reflection' inside its hollow tubes and finally conveys it to the ear so that it can be heard distinctly.

The modern stethoscope consists of a small metallic funnel or a hollow drum M which collects sound waves (Fig. 1). It is further connected to a small rubber tubing R which is attached to one end of a three-way metal tube T. To the other two ends of the T-tube are attached two ear phones E_1 and E_2 connected by rubber tubes R_1 and R_2. The doctor listens through these ear pieces when the funnel-shaped piece of metal M is placed on the surface of the body organ. The funnel carries a metallic disc C, which has a very sensitive diaphragm D encased in it. The density of material of the diaphragm is kept nearly the same as that of human skin so as to ensure maximum transference of the sound energy from the body organ under test to the diaphragm. S is the spring which helps the doctor in adjusting the distance between the ear-phones E_1 and E_2 thereby making the whole instrument quite flexible and convenient.

The metallic case M containing the sensitive diaphragm D is gently pressed against the body organ (e.g., heart, lungs, etc.) to be checked. The sound waves and the vibrations due to beating of this part of the

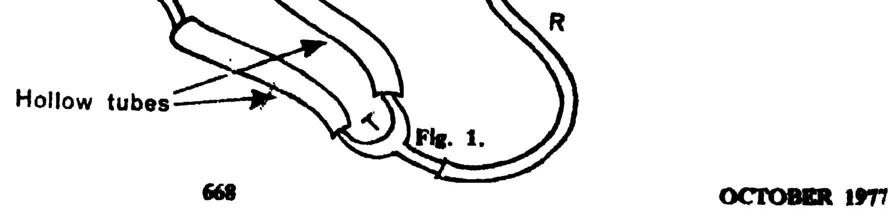


Fig. 1.

body are communicated to the diaphragm *D* which starts vibrating in resonance with a frequency equal to that of the original vibrations of the body organ. These vibrations are collected by the wide end of the funel and enter the hollow tubes R,T, R_1 and R_2 in which they are successively reflected internally from side to side. These tubes lead the vibrations to ear sthrough earpieces E_1 and E_2. In this way, the sound energy is concentrated in a much smaller space. As a result, the sound intensity reaching the ears is increased considerably. The original faint sound from the heart-beat or pulse-beat, which is exactly reproduced in the ear phones, can be amplified and heard distinctly.

Lungs lie in a cavity surrounded by ribs and the diaphragm. When a person breathes in, the diaphragm is lowered and the rib-cage expands so that some extra space is created. Air then flows into lungs to fill in the extra space. It has been observed that a number of chest diseases cause accumulation of a sticky fluid or mucus in lungs or in their surrounding cavity. When lungs are free from infections, tapping a healthy chest with flexed fingers or thumping the back produces a clear hollow sound. If they are infected, they become partly filled with mucus fluid and give out a dull, solid thud.

With the use of stethoscope doctors can make accurate diagnosis of chest diseases and follow fairly well the spread of the diseases in the body. It is also possible to detect presence of foetus in a pregnant woman, because the heart of the foetus beats almost twice as rapidly as that of an adult woman. This is, however, not the complete list of its medical applications.

B. K. SHARMA

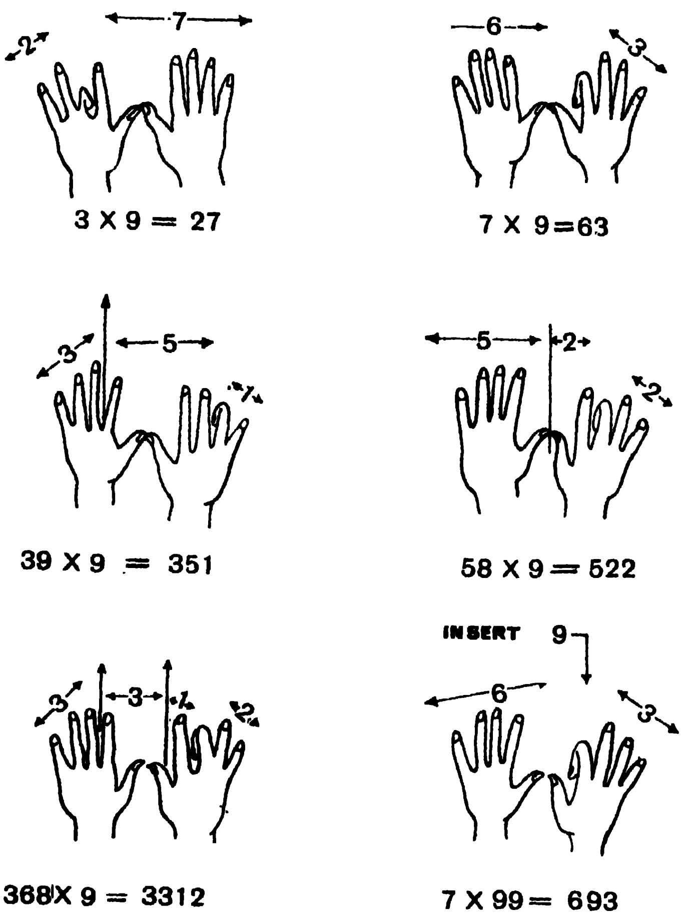
Finger multiplication

IN the *S.R.* (April 1977), some methods of multiplication were discussed. An interesting method of multiplication known as finger multiplication is given below. The method is useful only to multiply a given number with 9. The digits of the number which is to be multiplied must be in increasing order.

For example, in the number 246, the digits 2,4, and 6 are in increasing order. So the multiplication 246 × 9 is possible by this method. In the number 143 the digits 1, 4 and 3 are not in increasing order. So the multiplication 143 × 9 is not possible by this method.

1. Multiplication of one digit number by 9.

Suppose we want the product of 3 and 9. We bend in the third finger [Fig. 1 (a)]. Count the number of



3 X 9 = 27

7 X 9=63

39 X 9 = 351

58 X 9 = 522

368 X 9 = 3312

7 X 99 = 693

Fig. 1.

fingers to the left of the bent finger, which is 2. The number of fingers to the right of the bent finger is 7. So the required product of 3 and 9 is 27. Similarly, the product of 7 and 9 [Fig. 1(b)] is 63.

2. Multiplication of two digit number by 9

Suppose we want the product of 39 and 9. We put an arrow after third finger (Fig. 1(c) and bend the ninth finger. Count the number of fingers to the left of the arrow which is 3. The number of fingers between the arrow and the bent finger is 5. The number of fingers to the right of the bent finger is one. So the required product of 39 and 9 is 351. Similarly, the product of 58 and 9 [Fig. 1(d)] is 522.

3. Multiplication of three digit number by 9

Suppose we want the product of 368 and 9. We put two arrows after third and sixth fingers respectively [Fig. 1(e)] and bend the eighth finger. Count the number of fingers to the left of the first arrow, which is 3. The number of fingers between the two arrows is 3. The number of fingers between the second arrow and the bent finger is 1. The number of fingers to the right of the bent finger is 2. So the required product is 3312.

Similarly, the method can be extrapolated for the numbers having more than three digits.

4. Multiplication of one digit number by 99

Suppose we want the product of 7 and 99. We first bend the seventh finger [Fig. 1(f)]. Count the number of fingers to the left of the bent finger, which is 6. The number of fingers to the right of the bent finger is 3. Between these two numbers, 6 and 3, insert 9. So the required result is 693.

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Science Quiz

1. The refractive index of the glass used in an x-ray tube is

   (a) more than 1.5
   (b) equal to 1
   (c) less than 1

2. A substance in the gaseous state can be easily compressed because the molecules in this state

   (a) are small
   (b) are very close to each other
   (c) have large spaces among them

3. Life first appeared on the earth

   (a) on land
   (b) in air
   (c) in water

4. Neutron was discovered by

   (a) Niels Bohr
   (b) James Chadwick
   (c) Enrico Fermi

5. A man stands on a platform spring balance placed on the floor of a lift. When the lift is stationary, his weight is indicated by the balance as W kg. If the lift suddenly starts moving down, the weight shown will be.

   (a) W kg
   (b) less than W kg
   (c) more than W kg

6. Dynamo is a device which

   (a) converts electrical energy into mechanical energy
   (b) produces an explosive (dynamite)
   (c) converts mechanical energy into electrical energy

7. Oxidation process involves

   (a) increase in negative valence
   (b) loss of electrons
   (c) gain of protons

8. Which of the following planet is nearest to the sun?

   (a) Earth
   (b) Mercury
   (c) Venus

B. K Sharma

Science oddities

A fish that actually drowns if it is kept submerged in water is *Anabas*, popularly known as the 'climbing perch'. This odd little fish breathes with gills like other ordinary fishes, but doesn't stay and swim around in water. Instead, it walks about on land, using its tail and fins to propel itself, and is even said to climb trees in search of insects to eat. It is able to behave in this un-fishlike manner because it has special accessory breathing organs situated in a chamber above the gills. These rosette-shaped structures serve as air reservoirs, somewhat like lungs, enabling the fish to breathe atmospheric air like land animals.

'SILENT SOUND' may appaer to be a contradiction in terms, for by definition, sound is something we can hear. But 'silent sound' does exist—it is merely sound that is 'silent' or inaudible to human beings. It has been estimated that the average human ear can hear sounds with a frequency of about 15,000 vibrations per second. Keen ears can detect sounds of upto 20,000 vibrations per second. If the sound is more high pitched than this, we can no longer hear it. However, many animals like bats and dogs are able to hear these 'ultrasonic' sounds. Bats actually use these high frequency sounds to find their way in pitch darkness without bumping into obstacles.

WOOD is usually light enough to float in water, but not the wood of the ironwood tree. A characteristic tree of the Bornean swamp forest, the ironwood is aptly called *Metrosideros* (from 'metra', heart of a tree and 'sideron', iron), for its wood is so hard and dense that it will actually sink in water! The wood is very much in demand for making anchors, rudders, beams, etc., for not only is it strong enough to last well over a century without decay, but it even seems to be insect proof. The Japanese are said to have regarded it so valuable that only royalty was allowed the use of the wood.

FOR those who cannot concentrate on their work in noisy surroundings, the moon would be the ideal place to go for the study holidays. On the surface of the moon it is absolutely quiet, and even if someone were to bang a set of drums right next to you, it would not disturb the silence. This is because the moon has, unlike the earth, no atmosphere of its own and in the absence of air, the sound waves cannot travel. Another curious effect of the moon's lack of an atmosphere is that the moon-sky is black, not blue. On earth, the sky seems blue because of the atmosphere. It is the particles in the air that scatter the short light waves at the blue-violet end of the spectrum and make the sky appear blue.

THE chromosomes in the cells of every organism carry the hereditary information from one generation to the next. The number of these chromosomes vary greatly from species to species. *Aulacantha*, a tiny radiolarian, has sixteen hundred chromosomes! Why a simple, one-celled creature requires so many chromosomes, while the most complex and highly evolved animal, namely, man has only forty six, is a mystery.

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Answers to Science Quiz

1. (c)
2. (c)
3. (c)
4. (b)
5. (b)
6. (c)
7. (b)
8. (b)

Do it at home

Power alarm

MANY electric appliances, like refrigerator, need to be switched off in case of a power failure and switched on again when the power supply is resumed. During the day when the power goes off it is difficult to know when it had. The simple and inexpensive gadget described below will give a signal when there is a power failure and again when power is resumed.

The main circuit consists of a relay and a two-way switch with a bell and batteries. The relay has two sets of contacts, one which is closed when the relay is magnetised, and another when it is off.

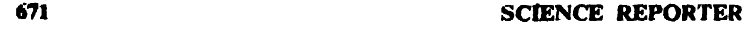
The working is simple enough. When the power is "on" the relay is pulled in and contact 2 gets closed. The two way switch is kept in position 3. In case of a power failure the relay springs back and closes contact 1 thus completing the bell circuit. The switch should now be reset to position 4 to stop the bell. When power comes back, the relay is again pulled. It closes contact 2 again and the bell sounds till the switch is reset to position 3. (Fig. 1).

The power for the relay is from the transformer-rectifier circuit. A suitable transformer compatible with the relay should be used.

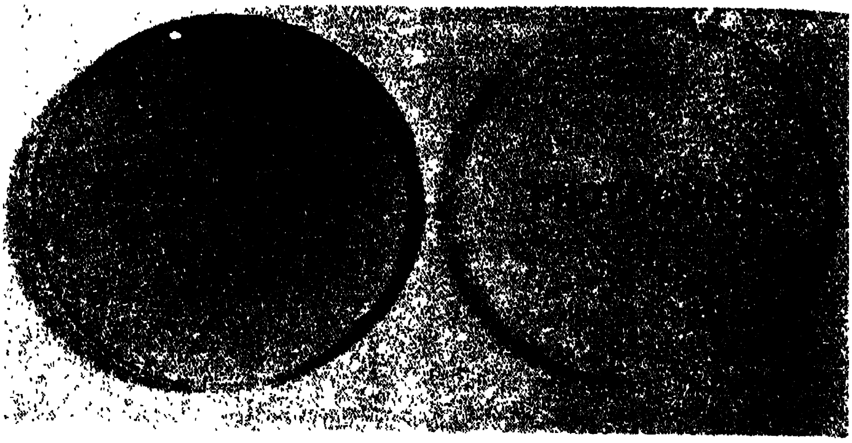
Components

T (Transformer)=9 V 200 mA, Delta BE 9 or equivalent
C (Capacitor)=1000 µf 12 V
D (Diode)=300 mA or more
R (Relay)=10 V 50Ω
Two way switch (S), 9V bell or butter, 9 Volt battery

SHILADITYA MAZUMDAR



Science in Industry



CGCRI develops photochromic glass

THE Central Glass & Ceramic Research Institute (CGCRI), Calcutta, has developed a process for the production of photochromic glass. Photocromic glasses are used as lenses for prescription spectacles and sunglasses for protection against glare. They are also used in window panes, windshields of cars and in other areas where dynamic control of sunlight as a function of its intensity is needed. Photochromic glasses also have applications in optoelectronic storage devices with self-erasing of information, and as modulators in optical transmitting systems where changes in the quantity of light may be used for control of regulatory purposes. At present, photochromic glass is entirely imported.

Photochromic glasses get deeply coloured on exposure to sunlight and ultraviolet radiations. The colour disappears on withdrawing the photochromic glass from the radiations. The photochromic process in these glasses is due to the reversible photodissociation of silver haldies. A very careful control of the composition, batch preparation, melting schedules, annealing and heat treatment is required to make the glass photochromic.

Protein chewy candy

PROTEIN chewy candy is a new product not available in the market at present. However, it may be liked by persons of all age groups as it is a new, tasty and nutritious confectionery. As such, a good demand for the product could be expected. The price envisaged for this product in the market is about Rs. 17/kg.

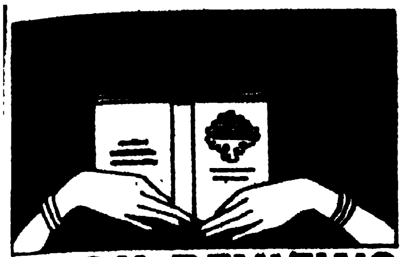
According to the process developed by the Central Food Technological Research Institute, Mysore, the necessary ingredients for chewy candy are taken and mixed with a thick sugar syrup and cooked in a steam-jacketed kettle with stirrer. The cooked mass is subjected to the usual operations like plating, rolling, cutting, wrapping and final packing. Many of the candy flavours available in the market have been found to be compatible with this confectionery.

The work has been carried out in the laboratory on 1.5 kg batch scale. In all, a quantity of about 100 kg of the product was prepared at the laboratory using this process. The candy prepared by this process contains 12-16 per cent protein and therefore could be used as nutritional supplement by children and persons of all age groups. The conventional candy manufacturers can use their existing facilities to produce this candy. This process has also been tried on 100 kg batches in a conventional commercial confectionary factory. The consumer acceptability of the product has been established with persons of all age groups, especially children.

The raw materials required are edible-quality solvent-extracted groundnut flour or protein isolate, sugar, liquid glucose, condensed milk vanaspati, suitable flavours and permitted food colours. All the raw materials are available indigenously.

The capacity of the suggested economic unit is 570 kg of chewy candy per 8-hr shift. The land required for plant and building is 500 sq. m while that for storage is 300 sq. m

The investment on plant and machinery and the working capital would be Rs. 1.80 lakh and Rs. 4.25 lakh respectively. The estimated cost of production is Rs. 11.40/kg of chewy candy.



BOOK REVIEWS

HANDBOOK OF FOOD AND NUTRITION by M. Swaminathan, *Ganesh & Company,* 71, Pondy Bazaar, Madras-17, Pp. 288, Rs. 12.00.

NUTRITION has been a neglected subject in India, though in this ill-nourished country information on nutrition should be available to all in the simplest form possible. Partly the cause of the dearth of information on this important subject in India is that few books have been written on it and fewer relevant researches have been done in our universities and institutes on what is good food for Indians of different ages, regions and occupations. Of late, some institutes have done some work on nutritional problems in India, but their researches touch only a fringe of the vast field.

One such attempt is the book written by M. Swaminathan, an expert on nutrition. The book has been written in a simple language and is moderately priced (Rs. 12 per copy) and covers a wide range of subjects under nutrition. The book will be useful to housewives, nutritional experts and students of home science, etc.

A common shortcoming in the treatment of this subject is that the nutrition values of different foods and feeds are invariably quoted from western sources which are valid for the foods available there. It is forgotten that the same food may have different values in different regions of the earth. For instance, milk, eggs or tomato available in US vary in nutrition values from those available in India. Therefore, quoting the nutritive values of the foods of western countries may be misleading in the Indian context. It is time that our experts do research for determining the nutrition values of foods available in India. Such a research effort will give a correct picture of the quality of food that we take and also will be a better guide to what we should eat and in what quantity. Our dependence on foreign data for nutrition values of foods should now be given up.

The author has recommended some ideal diets for various age groups and for men and women in different occupations. Here, the information has been given in a scientific language which will not make sense to lay readers For instance, when you say that a pregnant woman needs more calories and proteins, she will be at her wit's end to know precisely how much more milk or how many more eggs she should add to her normal diet. Instead of describing ideal foods in terms of calories and proteins, the author should have given this information in terms of weights so that the information makes immediate sense to lay readers.

DESIGN=OUT=MAINTENANCE AND INSTRUMENT AIDS by Durgesh Chandra, *Universal Book Corporation and Instrument Association of India*, Ahura Printing Press, Bombay, Pp. 281.

WHILE India has built a large industrial enterprise its productivity is dismally low. A Japanese steel worker produces 200 tonnes a year compared to 60 tonnes by an Indian. America produces 1400 tonnes of cement per man-year while the figure for India is 190. America's aluminium productivity is 200 tonnes per man-year as against 25 tonnes in India. The figure for sugar is 450 tonnes in the USA and a meagre 24 tonnes for India.

Why is Indian productivity so low ? Can it be improved? This is the subject matter of the timely book by Mr Durgesh Chandra, an experienced plant engineer. This comprehensive volume describes several ways to maximise production, reduce waste, and increase safety and efficiency of plants.

Productivity is the ratio of output of goods and services to the input of resources like materials, money, machinery and manpower—or what Mr. Chandra calls 4M's. He argues that this ratio can be improved by Design-out-Maintenance or DOM. It is a technique which, in simple terms, means that the health of the machines, like that of a human body, must be measured while they are working and not after they break down. DOM also means that logical questions must be asked and answers found whenever a machine develops defect: What is the cause of the defect? Can the defect be eliminated? Is there a way to detect the defect when the machine is working? Can the machine be eliminated from the plant? If so, what is the alternative way of performing the function which the defective machine is assigned to do?

The book is full of case studies pertaining to a rayon plant and examples of specific applications of DOM technique.

The book gives a long list of instrument aids to monitor the machine's health while working. The techniques are described in detail particularly in regard to vibration analysis, ultrasonic flaw detection, radiography and dye penetrants. Noise and vibration analysis, according to the author, is one of the most important aspects of maintenance in the industrially advanced countries. Ultrasonic gauge can be used to measure thickness of metals and articles like aircraft propellers, large flat sheets of steel and aluminium, castings, seamless tubes, ship plates and storage tanks as accurately as a micrometer.

The author describes the application of pert chart and queueing theory in maintenance and has developed certain "indices" for evaluating maintenance work. Maintenance is an integrated system which derives sustenance from other branches such as financial management, personnel management, materials management and network analysis. Mr. Chandra has nicely knitted together these various aspects and brought out their interrelationships under one roof which covers budgeting, organising, on-stream test, flaw detection, non-destructive testing, safety aspects, tribology and materials management.

The book may be of great help to maintenance engineers, project managers, industrial executives and manufacturers of instruments and consulting engineers engaged in the design and supply of instruments and control systems for non-destructive testing.

K. S. JAYARAMAN

INDIAN SCIENCE INDEX 1975

Edited by Satya Prakash and Compiled by Syed Mohammed Ali and Har Saran Sharma, *Indian Documentation Service*, Gurgaon/New Delhi, 2, Ansari Road, Panna Bhawan, Daryaganj, New Delhi-110002, Pp. 140, Rs. 50.00.

OFTEN, Indian scientific and technical journals are underestimated. Even an Indian research worker wishes to publish his work in a reputed foreign journal than in an Indian journal. Our elderly scientists also give more weightage to a paper published in a foreign journal. As a result, most of the research work done in our country is published abroad. The amount of literature published in Indian journals is a small percentage of the total literature published by Indians. So, a bibliographical organisation, attempting to cover every expression of Indian thought, would have to seek help more often of foreign journals rather than Indian ones. Confining to Indian journals would mean a highly incomplete study of Indian thought in a particular discipline. Therefore, such a bibliographical record has a limited utility for a researcher.

The above fact, however, in no way lowers the value of the maiden attempt made by *Indian Documentation Service* to produce this bibliography of Indian scientific and technical literature. It is a beginning in a direction in which we have a long way to go. This index is the first of its kind, and is the first annual volume of Indian Science Index. It is a subject index to articles, research papers, research notes, conference/seminar/symposia proceedings, transactions of societies, significant editorials, scientific news and book reviews from selected Indian journals in all disciplines of science, technology and medicine. The present volume lists over six thousand articles derived from 150 journals published during 1975. It lists the titles of the publications alphabetically on the dictionary pattern. But many important journals and periodicals have been left out. It is hoped that in the future issues of this science index more journals and periodicals would be added. It would be excellent if a cummulative bibliography of last ten years of Indian technical literature is published, along with the abstracts, more particularly of conference/seminar proceedings.

RAVINDRA N. GOEL

AN INTRODUCTION TO THE TAXONOMY OF ANGIOSPERMS

by Y. D. Tiagi and Shashikala Kshetrapal, *Ramesh book Depot*, Jaipur, Pp. 444, Rs. 24

PLANT Taxonomy constitutes a vibrant aspect of botany dealing with identification, nomenclature and classification of plants. Although representing the most ancient of plant sciences, it has now acquired a distinct interdisciplinary bias and the contemporary taxonomist is increasingly involved in grappling with the intrinsic principles underlying the evolution and relationships among plants. The rapid strides taken in this direction have left a void in our curriculum and texts, and there is indeed an urgent need for a book which would reflect kinesis of this discipline. The present volume, although an improvement over the existing Indian books on the subject, fails to live up to this modest demand.

After a brief introduction, which, curiously, deals with some rather intricate problems of delimitation and interrelationships of major groups of flowering plants, a few pages are devoted to the meaning and scope of plant taxonomy. This treatment is orthodox and insufficient and the archaic overpowering influence of floristics envelopes the succeeding pages. The concepts of taxonomic categories are shorn of current ideas and thinking. For example, the biological species concept is barely mentioned, and only some stray infraspecific categories are defined. The chapter on plant nomenclature might prove useful because of the simplicity of presentation. The details of Indian herbaria and botanic gardens, too, are welcome, but the information appears to be factually incorrect at several places. It might seem gratifying to learn that the herbarium of Forest Research Institute, Dehra Dun, houses 35 lakh plant specimens, and is larger than the herbaria at Cambridge, Paris, Vienna, and Zurich, but a lot of facts are needlessly sacrificed in the process of catering to such patriotic sentiments. Some high-placed Indian botanists have likewise been erroneously accredited with outstanding contributions to herbaria gardens and to several other fields of taxonomic activity.

The major part of the book is devoted to descriptions of some selected (according to university syllabi) families of angiosperms which are arranged according to an obsolete system of classification. The last chapter, which deals with the interesting problem of phylogeny of angiosperms, could have been more useful if the relevant works of modern investigators such as Behnke, Walker, Lundquist, Axelrod and Favre-Duchartre were also taken into account.

Among the serious drawbacks of the volume are its total apathy toward modern aspects of taxonomy and the glaring ignorance of recent developments in the field. The erudite reader would also be embarrassed to find that a sizeable part of the information taken from other books is not appropriately acknowledged. The line-drawings are tolerable but the text is replete with errors. If one feels that even impure water is good for the thirsty, the book may be recommended to students. This is because there is hardly any other book available in Indian market which offer even a semblance of justice to this important branch of botany.

A. K. BHATNAGAR

LABORATORY MANUAL OF INORGANIC CHEMISTRY by H.M. Chawla, A.C. Handa, R.C. Rastogi, *Sultan Chand and Sons*, 4792/23, Daryaganj, New Delhi-110002, Pp. 185, Rs. 5.00.

THIS book has been written for B.Sc. General and Honours students of Indian Universities. It covers various methods of inorganic analysis. Essentially, the book has not succeeded in its aim as formulated in preface, i.e., to fill the gap between the theory and the experiment. Authors have made no effort in this direction. It seems they preferred to give various schemes of analysis as a mere story without discussing the principles involved. At the same time, authors have made no attempt to familiarize students with various laboratory techniques. Practically no illustrations have been given which are rather necessary for undergraduate students in understanding the subject.

First few chapters of the book deal with the methods of qualitative analysis which includes semi-micro-qualitative analysis and also chromatographic methods of separation of some radicals. Authors have discussed the precipitants other than H_2S, such as thioacetamide and potassium trithiocarbonate. Further chapters discuss quantitative methods of analysis. Various volumetric methods such as acidimetry and alkalimetry, redox titrations, iodometry, precipitation titrations and complexometric titrations, etc., have been discussed. Another chapter deals with various gravimetric methods of analysis. One chapter has been devoted to inorganic preparations. As usual, several appendices have been given at the end of the book.

ASHOK KUMAR GUPTA

ELECTRICITY AND MAGNETISM by D. L. Sehgal, K.L. Chopra, and N. K. Sehgal, *Sultan Chand and Sons*, (as above) Pp. 757. Rs. 20.

THIS is yet another volume which is an addition to the family of books on electricity and magnetism. It has no outstanding feature that needs special mention. Rather, it has been written with a view to present only one volume on the subject. It includes subject matter needful for students appearing in graduate or competitive examinations.

The book, as per the convention, is divided into three parts: (a) Electrostatics, (b) Magnetostatics, and (c) Current electricity. All these parts have been described in the usual fashion but more elaborately. More than half of the text is devoted to current electricity. This part is exhaustive and the chapters on electromagnetic induction and magnetic properties of materials are interesting. The parts on electrostatics and magnetostatics have been described in an easily undertandable language. They cover basics like principles, fields and potentials. Dielectrics and terrestrial magnetism have been well presented.

The book is in M.K.S. system of units. However, at places the formulae in C.G.S. system have also been given. The compilation of electrical units in one chapter needs appreciation. The text is well illustrated and explained, but sometimes the language seems borrowed. As the standard texts mention vector analysis to discuss various principles of electricity and magnetism, the authors have devoted one chapter on vector analysis.

An interesting feature of the book is that each chapter has been summarized at the end, where a special care is given to unit systems. Many solved and unsolved examples have been included in all the chapters, which end with a series of questions. This scheme of presentation has raised the quality of the book. Sometimes the subject matter is so technical that it is difficult for a general student to understand it.

The book will be of use to B.Sc. (Pass and Honours) students.

VIJENDER SHARMA

SPICES AND CONDIMENTS by J. S. Pruthi, *National Book Trust*, A-5 Green Park, New Delhi-110016, 1976, Pp. 270, Rs. 14.50.

THIS semi-technical book on spices and condiments, though it lacks agricultural, technological and marketing aspects, is still a storehouse of information for a technical person as well as for a layman. The above mentioned missing information, however, can be obtained from other sources.

The book is written in a lucid language and presents to the reader the scientific and vernacular names of spices, their synonyms, and geographical distribution, morphological description, physical and chemical properties of about seventy spices. Some of the spices not used in India but described in this book enhance our knowledge of spices used elsewhere. Two annexures showing export, area and production of some spices though outdated still give an idea of the potential that India possesses in these fields. Some typographical errors have persisted even though an errata has been included at the end of the book. The limited number of plates though informative are badly printed.

Those who deal in'desi' medicine will find some useful information in this book and it will also help the layman in finding the uses of many of the spices in household remedies. The cost of the book, is, however, high as compared to other National Book Trust publications.

M. ILYAS

PROBLEMS IN PHYSICS by B. L. Dhar, K. L. Chopra, N. K. Sehgal, and D. L. Sehgal, *Sultan Chand and Sons*, 4792/23, Daryaganj, New Delhi-110002, Rs. 20.00

THE present physics syllabi of our universities hardly lay any emphasis on solving problems and most of our examinations consist in mugging up the text-book material and then reproducing it in the examination hall. This state of affair is deplorable, particularly when in a subject like physics understanding of concepts and techniques is crucially dependent on problem solving. This problem is further aggravated by non-availability of good books on the techniques of problem solving.

The book under review, as claimed by authors, is written to fill this gap. The book is confined to the B.Sc. syllabus of Indian universities. It is divided into two volumes, first dealing with mechanics, heat, and optics; the second volume dealing with sound, electromagnetism, and modern physics. In each chapter of the book, the authors just give solved examples. This makes the title of the book inappropriate; it would have been better if the title were 'Solved Examples in Physics.' The book would have been certainly more useful if the authors had given only hints to solve the problems. A list of important formulae before the beginning of each chapter is theonly redeeming feature of the book.

MANMOHAN GUPTA

Books Received

1. **EARTH, THE LIVING PLANET** *by* Michael J. Bradshaw, *Hodder and Stoughton*; Available at B. I. Publications, 359, D. N. Road, Bombay, 400023, Pp. 302, Rs. 79.20 (£ 4.95)
2. **INVERTEBRATES** by R. L. Kotpal, S. K. Agarwal, R. P. Khetarpal, *Rastogi Publications*, Shivaji Road, Meerut-250002, Pp. 660, Rs. 17.50
3. **RECENT ADVANCES IN MINING AND PROCESSING OF LOW-GRADE AND SUBMARGINAL MINERAL DEPOSITS** *by* Centre for Natural Resources, Energy and Transport, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 192, $ 25.00
4. **ADVANCED SECOND YEAR T.D.C. PRACTICAL PHYSICS** by S.L. Kakani, H.B. Saxena, and M.S. Lodha, *The Student's Book Co.*, Chaura Rasta, Jaipur-302003, Pp. 184, Rs. 7.50
5. **FIRST YEAR T.D.C. NUMERICAL PHYSICS**, Kakani, Saxena and Mathur, *The Student's Book Co.*, (Same as above) Pp. 311, Rs. 12.75
6. **FIRST YEAR T.D.C. PHYSICS** by Kakani, Saxena, Jain, Khamesra, Sokhi, *The Student's Book Co.*, (Same as above) Pp. 615+supplement, Rs. 22.75

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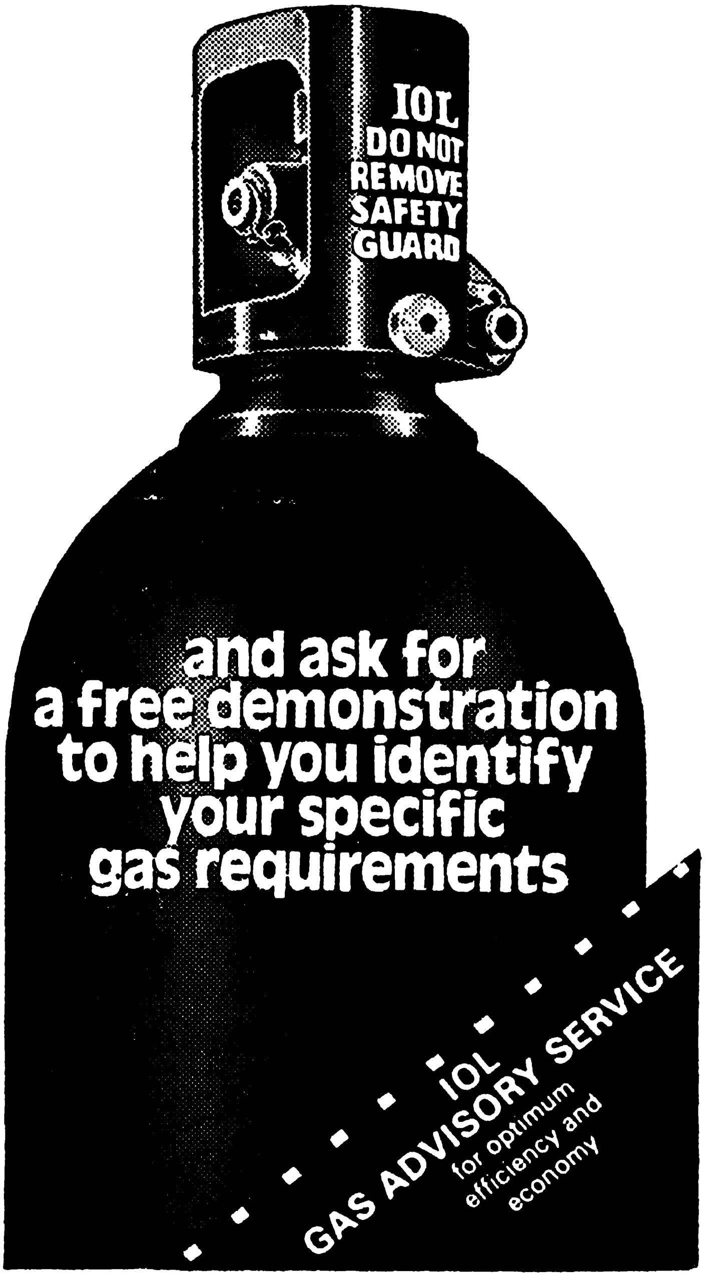
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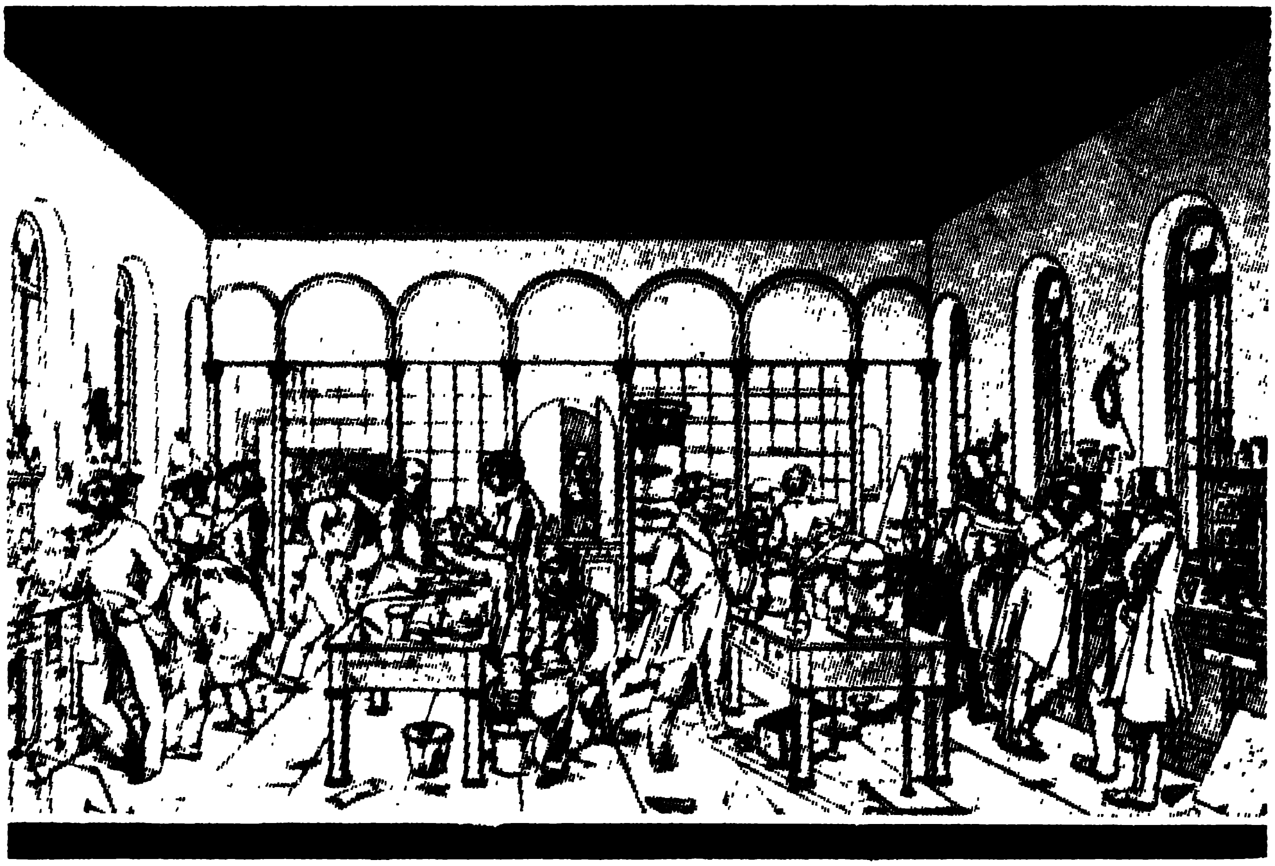

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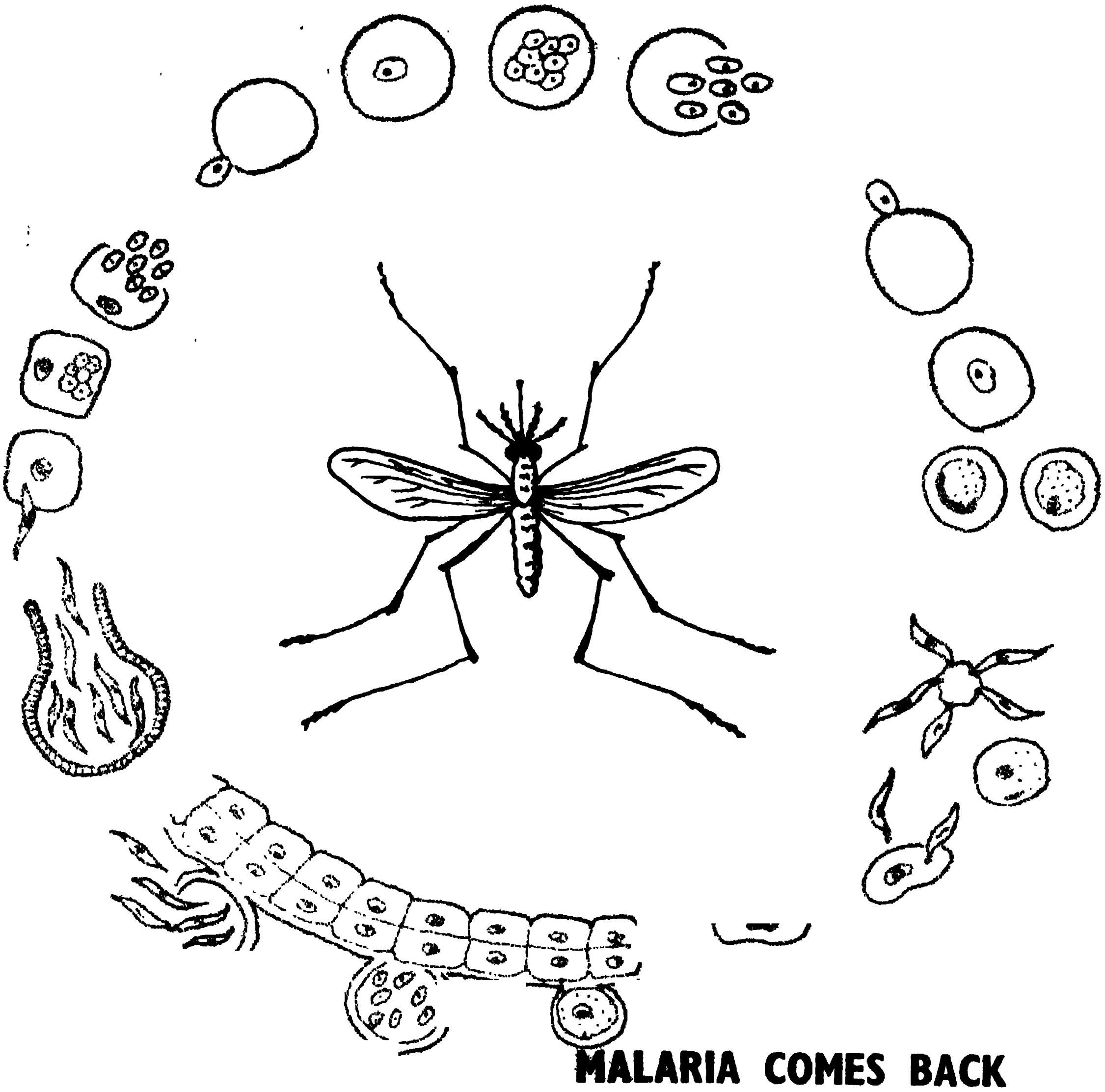

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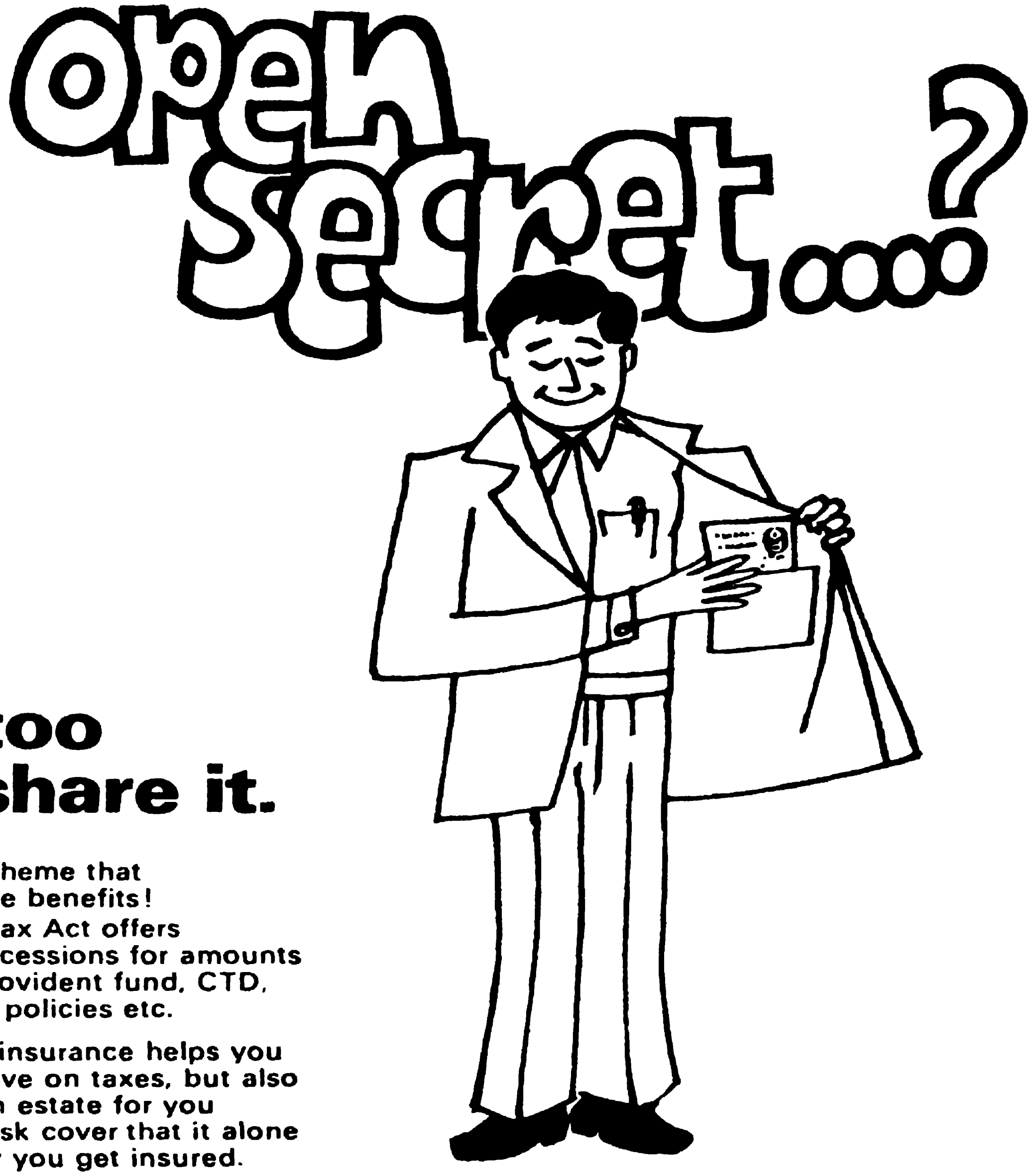
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LETTERS

Tidal power

Sir, Thank you very much for publishing the excellent article **Tidal power** (*S.R.*, August 1977). The authors have, however, missed a few points and also the work done by Central Water and Power Research Station, Khadakwasla, near Pune.

The Gulf of Cambay resembles the Bay of Fundy between USA and Canada. Tides in the Gulf of Cambay are comparable to the tides in the Bay of Fundy which has the world's greatest tidal power potential. The high tides in the Gulf of Cambay are a result of resonance phenomenon. This occurs whenever a totally reflecting and semi-enclosed body of water has such a depth and length that the tidal wave covers a quarter of the wavelength in 12 hours and 25 minutes between successive tides. If a gulf is longer than the resonant length, it is possible to shorten it by building barrages and thus increase the tidal range. If a particular body of water is less than the resonant length, construction of a dam will only diminish the very tidal range the dam is being constructed to exploit.

It is, therefore, necessary to undertake a mathematical model study of the four creeks in the Gulf of Cambay and Kutch involved in tidal power proposals and to examine the most likely hydraulic effects of the schemes. Such work is still under development but considerable progress has been made in Canada and U.K. Studies about the effects of barraging the estuary on the tidal range, which help in the search for optimum site and a more scientific planning than by simply drawing lines on a map, should be undertaken immediately. The research centre at Pune has conducted a feasibility study and confirmed the tremendous potential of tidal power on the coast of Gujarat and Saurashtra. United Nations Development Fund has sanctioned $2.2 million aid to the Pune centre.

According to the Station Director of the Pune centre, Dr. Saxena, the best source of tidal power in India is around the Gulf of Cambay; it could generate 6,000 MW to 7,000 MW of electricity. He is very optimistic about the development of tidal power in India. According to him, the Gulf of Cambay and Kutch taken together could contribute nearly 40 per cent of the power generated in India today.

G. V. JOSHI
ONGC, Bombay

Binary system

Sir, My thanks to Bharati Banerjee for her article **Binary system** (*S.R.*, June 1977). The article is very interesting. I would like to know the following :

1. How, in binary system, is $(11)_2+(11)_2=(1010)_2$ (as mentioned by the author on page 359, line 9) ?
2. How are the random additions and substractions represented in 'row and column arrangements'?
3. How is binary system applied in the operations of computers and calculators?

I request you to publish another article regarding the application of binary system in digital electronics.

SUBRATA BANERJI
P&T Wireless Station
Calcutta-700050

1. Please *read* page 359, line 9 as $(11)_2 + (11)_2 = (110)_2$ *for* $(11)_2 + (11)_2 = (1010)_2$. It was a printing error.

2. The representation of random additions and subtractions of all the binary numbers into a 'row and column arrangement' is not suitable Only basic fact about binary addition and multiplication is written in 'row and column arrangement' which is easy to remember.

3. In binary numbers we are using two symbols 0 and 1 only. These two symbols precisely match the two states, 'off' and 'on' of an electric circuit as well as the logic of choice, 'yes' or 'no'. For further clarification it is required to explain how numbers are stored in 'memory'—a part of the computer, and how they work

II

Sir, The article **Binary system—the basis of calculating machines** by Bharati Banerjee (*S.R.*, June 1977) was very interesting, both from academic and recreational point of view. Undoubtedly, binary system has done away with much of the botheration of number symbols of the denary system, and has made basic mathematical rules, viz., addition, subtraction, multiplication and division, easier and faster for operation. Its contribution to cybernetics and computation is also significant. Its introduction in school syllabus, however, may be a debatable question, particularly when our teachers are not thoroughly trained in this new system.

I have the following problem. Suppose we have to add $(13)_{10}$ + $(9)_{10}$ + $(15)_{10}$. Converting this into binary system we have $(1101)_2$ + $(1001)_2$ + $(1111)_2$ respectively. When we add, the result is not accurately written because I do not find any way to express the number 12 at the place. If I write 1100 the result is $(1100101)_2$ which becomes $(101)_{10}$. The result should, however, be $(37)_{10}$.

If I write merely $(11101)_2$, it becomes $(29)_{10}$ which is also not correct. I am not able to solve this puzzle. Can you help me?

Md. Afzal
Zoology Deptt.
Bhagalpur University
Bhagalpur-812002

The problem may be solved as under :

$$(13)_{10} + (9)_{10} + (15)_{10} = (37)_{10}$$

$$\begin{array}{ll} \text{Now} & (13)_{10} = (1101)_2 \\ & (9)_{10} = (1001)_2 \\ & (15)_{10} = (1111)_2 \\ \hline \text{Add} & (37)_{10} = (100101)_2 \end{array}$$

It is easy to verify $(37)_{10} = (100101)_2$. In binary system $1+1+1+1 = 100$ *and not* 12.

Bharati Banerjee
Department of Mathematics
Shri Shikshayatan College
Calcutta

Prostaglandins

Sir, Thank you for publishing the informative article **Significance of prostaglandins** (*S.R.*, July 1977). The author has briefly mentioned all about the PGs except its action on the eyes.

In 1957 Ambache showed that a substance with vasodilating properties is released when the iris is stroked; he named this iris extract 'irin'. Now irin seems to be a mixture of prostaglandins E and F. All the PGs which have been studied, except PGF_1 alpha, cause a rise in intraocular pressure due to increased permeability at the blood-aqueous barrier of ciliary epithelium, with rise in the protein content of the aqueous humour.

Local drops or injection in the eye cause constriction of the pupil, dilatation of blood vessels, increase in permeability and rise in intraocular pressure. This response can be seen following any physical or chemical offense to the eye and is thought to be due to release of PG. But surprisingly, the intravenous injection of the drug fails to increase the intraocular pressure.

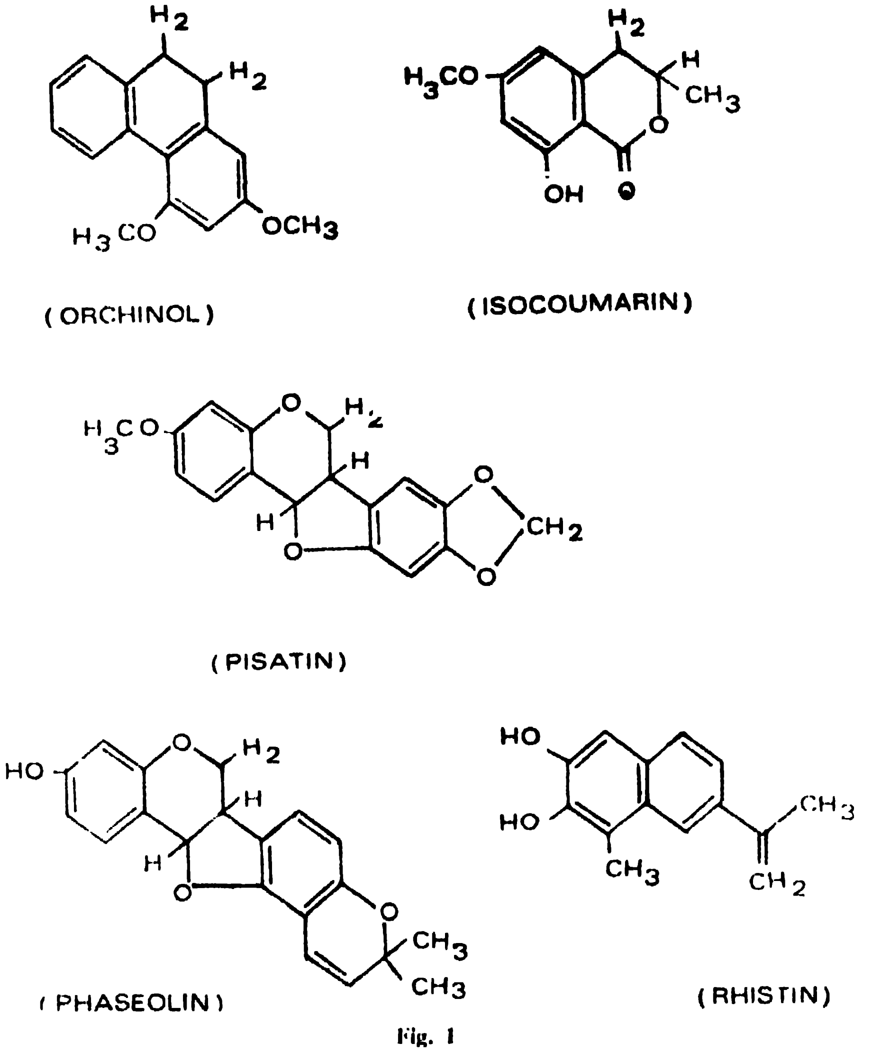
Swadesh C. Acharjee
Department of Ophthalmology
Lady Hardinge Medical College
and Hospital, New Delhi

Phytoalexins

Sir, I read the article **What are phytoalexins?** by B.S. Singh and T. Satyanarayana (*S.R.*, July 1977) with interest. The article was not very informative and some of the molecular structures shown were wrong. I would like to add the following points.

1. The synthesis or accumulation of phytoalexins (from the greek *phyton*—plants, and *alexin*—warding off compounds) and other phenolics is not specifically induced by pathogens only. Nonbiological stimulation has also been reported. For example, chemical and mechanical injuries are also able to induce accumulation of these compounds in plants.

2. It appears that plants have the potential to synthesize these phenolic compounds and that the infecting fungi determine their rate of synthesis by the hosts. For example, the concentration of isocoumarin varies from 5μg/gram to 342μg/gram in carrot,



(ORCHINOL) (ISOCOUMARIN)

(PISATIN)

(PHASEOLIN) (RHISTIN)

Fig. 1

depending upon the organisms used for infection.

3. In recent years several phytoalexins and phytoalexin-like compounds have been obtained. Some of them are:

(a) *Phaseollin* : It has been obtained by inoculating detached, open pods of *Phaseolus vulgaris* with *Monilinia fructicola.*

(b) *Rhistin* : It has been obtained by infecting potato tubers (*Solanum tuberosum*) with *Phytophthora infectans.*

Structures of phaseollin and rhistin are as shown in Fig. 1.

4. Pisatin is a phenolic ether, while phaseollin is a phenol, and rhistin is a bicyclic norsesquiterpane alcohol.

5. Structures of orchinol, isocoumarin and pisatin given in the article (p.451) are also wrong. The correct structures are given (Fig. 1).

Further reading

1. Cruickshank, I.A.M. (1963), Phytoalexins, *Ann. Rev. Phytopathol.*, 1, 351-374.
2. Goodman, R. N., Kiraly, Z. and Zaithin, M., (1967), *The Biochemistry and Physiology of Infectious Plant Disease*, D. Van Nostrand Company (Canada), Ltd.
3. Muller, K. O. (1961), The phytoalexin concept and its methodological significance, *Recent Advances in Botany* 1, 394-400.

U. C. Jha
Deptt. of Post-Graduate Studies and Research in Botany,
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Jabalpur (M.P.)

Snakes and music

Sir, Prof. B. K. Behura has given a lot of interesting information in his well-written note **Do snakes appreciate music?** (*S.R.*, July 1977).

The fact that snakes can receive airborne sounds was first reported in 1960 by E. G. Wever and J. A. Vernon of U.K. (*J. Auditory Res.*, 1 77, 1960). They demonstrated that the inner ear of snakes responds electrically to airborne sounds as well as earthborne vibrations and are quite sensitive to a limited range of sounds of low wavelength (usually 100-500Hz). It was, however, not known what part such responses play in the normal behaviour of snakes. The discovery of Dr. P. J. Deoras and others is, therefore, a significant addition to the understanding of the snake behaviour in response to airborne sounds.

Samar Chakrabarti
Deptt. of Zoology
Hooghly Mohsin Govt. College
Chinsurah, W.B.

Hyperchromic anaemia

Sir, Anaemia by definition is a qualitative or quantitative deficiency of the red blood cells. As hemoglobin is the colouring matter of red cells, its quantity per unit volume of cells is the index of colour. It is expressed as mean corpuscular hemoglobin concentration percentage:

$$\text{MCHC}\,\% = \frac{\text{Hemoglobin per 100 ml. blood}}{\text{Cell volume per 100 ml. blood}} \times 100$$

The normal value is 32 to 38. The maximum MCHC is 38% and it cannot be increased, for red cells cannot hold a greater concentration of hemoglobin. A hyperchromic state does not exist. Anaemias with MCHC 32% and above are normochromic and those with MCHC below 32% are hypochromic.

The term hyperchromia is used by people who employ "colour index" as an index of colour. The colour index is obtained by dividing the hemoglobin expressed as a percentage of normal (100 per cent = 14.5 g.) by the red cell count expressed as a percentage of normal (assumed for convenience to be 5 million). This 'colour index' expresses the mean hemoglobin content of a single cell as compared with that of an arbitrary normal cell. Calculation of MCH (mean corpuscular hemoglobin) is a better method to find out the hemoglobin content in a cell. CI and MCH serve the same purpose.

A big cell, twice normal in size having 50% saturation with hemoglobin will have MCHC (true index of colour) 50% of normal. The MCH and CI for this truely hypochromic cell will be normal (100%). For a saturation of 60%, the MCHC will be 60% of normal but the MCH and CI will be 120%. People who use the 'colour index' as an index of colour will call the hypochromic state as normochromic (first example) or even hyperchromic (second example). The confusion is created by the use of the obsolete term 'colour index' in place of mean corpuscular hemoglobin concentration (MCHC) percentage as the index of colour.

K. Sughathan
Associate Professor of Cardiology
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Ground water

Sir, Please publish an article or a short note on various types of ground water, their dissolved constituents and their estimation by simple and latest techniques. It would be worthwhile to have data on the limits of various dissolved solutes in water to be used for human consumption.

D. Sreedhar
Calcutta

Vitamin C

Sir, Apropos of the article **Vitamin C** (*S.R.*, Dec. 1976), I would like to quote the following from the after-dinner speech on *Current Status of Vitamin C and Future Horizons* at the Second Conference on Vitamin C (Oct. 1974 in New York) by Dr. C.G. King of the Institute of Human Nutrition, College of Physicians and Surgeons, Columbia University, New York: "A few enthusiastic laymen and some physicians suggest practices such as a regular intake in the range of one gram or more each day. Claims are made that these very large intakes are harmless. Others with excellent experience in medicine, public health and biochemistry believe that such large intakes have little, if any, significant value and entail significant hazards to health such as kidney and bladder stones and alterations in carbohydrate metabolism. Thus far, there has been little evidence to indicate the mechanisms to account for the claims made in supporting the high dosages." (*Annals of the New York Academy of Sciences, Vol. 258, Sept. 30, 1975, Pp. 540-545*). Over fifty scientific papers on vitamin C were presented at the conference.

The suggestion of S. Ramakrishnan in the *S.R.* that "a person with normal metabolism can conveniently go in daily for 1 to 2 g of vitamin C to look young, to ward off disease and to be healthy" needs unequivocal justification, before adoption, by clinical, biochemical and nutritional studies.

S. SANKARA SUBRAMANIAN
Professor & Head
Deptt. of Chemistry
JIPMER, Pondicherry-6

II

Dr. S. Sankara Subramanian likes to know the views of clinical experts and nutritional advisers on the feasibility of taking 1 to 2 grams of vitamin C daily by normal individuals.

Geoffrey H. Bourne of Yerkes Primate Centre, Emory University, Atlanta, USA, whose article on "Vitamin C—Myth or Miracle" has been quoted in the letter (*S.R.* Aug. 1977) says "It may be possible that when we are arguing whether 7 mg or 30 mg a day is an adequate intake, we may be very wide off the mark. Perhaps we should be arguing whether 1 gm or 2 gms a day is the correct amount" (*The Baroda Journal of Nutrition*, Vol. 1, No. 2, Nov. 1974, p. 143).

Prof. A. Szent Gyorgyi (Hungary) who received the Nobel Prize in Medicine and Physiology for the identificatiom of Vitamin C writes that he takes about one gram of vitamin C per day (*The Baroda Journal of Nutrition*, 1, 145, 1974).

Dr. Linus C. Pauling (Nobel Laureate in Chemistry, U.S.A.) recommends a much larger daily dose of 1.8 gms to 4.1 gms to have beneficial effects of vitamin C on common cold (*The Baroda Journal of Nutrition, loc cit*, p. 144). Dr. Pauling's claim has obtained support from clinical studies carried out in Canada and Ireland (*The Baroda J. Nut., loc cit*, p. 144).

Drs. C.W.M. Wilson and H. S. Loh, pharmacologists of the University of Dublin, Ireland, recommend a daily dose of 2 g of vitamin C to have a prophylactic effect against common cold (*The Lancet*, 1,641, 1973). To achieve tissue saturation these workers emphasize the need for a liberal dose of vitamin C because it is easily eliminated from the body. They say such a liberal dose will help get over the risk of coronary heart disease (*The Lancet*, 2, 317, 1973).

In 1974, chemists, biochemists, clinicians and food technologists who met at the National College of Food Technology near London discussed the many rules of the modest white powder and came up with one clear message that mega doses of the vitamin (at least one gm a day) are almost certainly harmless.

Regarding toxicity, G. H. Bourne says there is no evidence that even doses as large as 4 or 5 grams daily have any toxic effects at all. A dose of 25 grams daily for 2 months, he says, had no discernible toxic or other effects except a mild diuretic one (*The Baroda Journal of Nutn., ibid*, p. 144).

Among the experts referred to above, there are two Nobel Laureates who do not simply preach to the public but practice by taking a mega dose of vitamin C daily even in their normal health.

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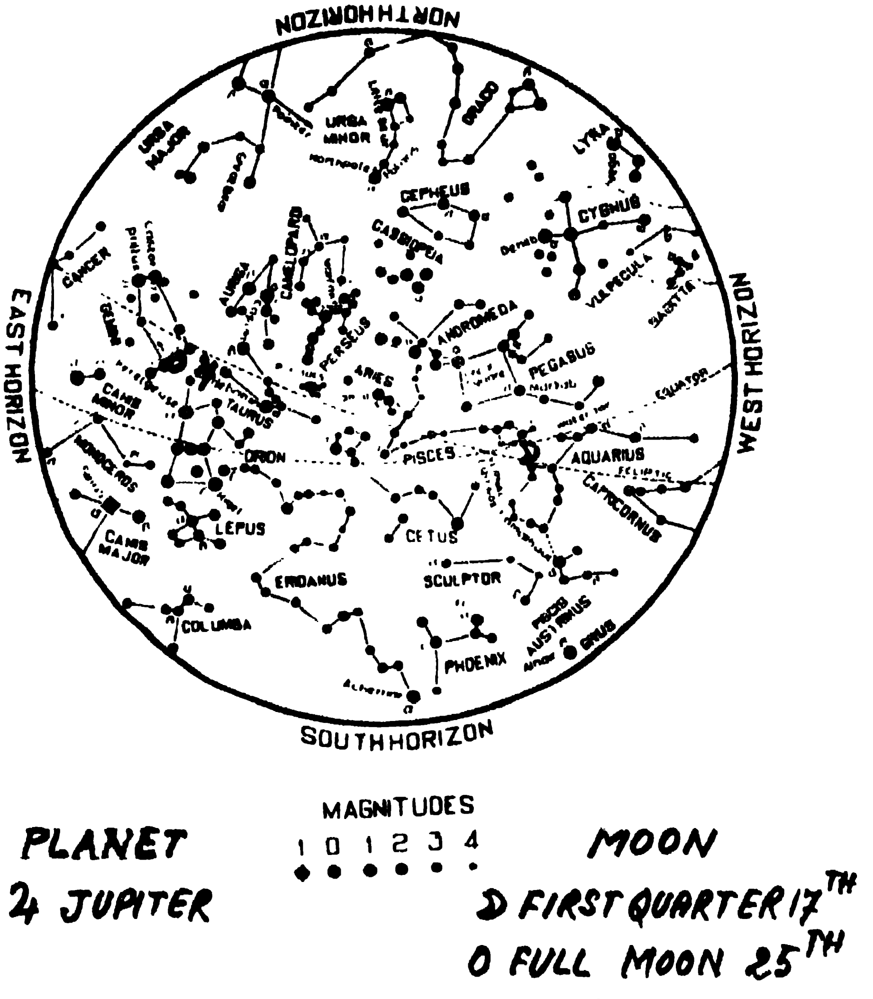
605006

Planets and their positions

DECEMBER 1977



The moon

THE new moon day is 10th at 11.03 p.m. and the full moon 25th at 6.19 p.m. I.S.T.

The moon passes about seven degrees south of Mars on 1st, five degrees south of Saturn on 3rd, about three and a half degrees north of Venus on 10th, six degrees north of Mercury on 12th, about four and a half degrees south of Jupiter on 25th, again eight degrees south of Mars in the night of 28th and about five degrees south of Saturn on 30th.

The lunar crescent becomes first visible after the new moon day in the evening of 11th.

The moon is at perigee or nearest to the earth on 11th and at apogee or farthest from it on 25th.

The sun is at the winter solstice on 22nd.

The planets

Mercury (Budha), an evening star sets about one and a half hours after sunset during the It is half of the month. Thereafter, it is too near the sun to be visible. It is in inferior conjunction on 21st. It is at the greatest eastern elongation of about 21° degrees from the sun on 3rd and becomes retrograde on 12th. At the fag end of the month, it re-appears as a morning star and rises about an hour before sunrise. It moves from Sagittarius (*Dhanus*) to Scorpio (*Vrischika*) by retrograde motion. Its visual magnitude varies from 0.2 to +1.1 in the first half of the month and again varies from +1.7 to +0.7 in the second half.

Venus (Sukra), visible in the morning sky rises about half an hour before sunrise during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It passes five degrees north of the star Antares (*Jyestha*) in the early hours of 11th. It moves from Scorpio (*Vrischika*) to Sagittarius (*Dhanu*. Its visual magnitude is about -3.4.

Mars (Mangala), visible in the eastern sky, rises about three hours before local midnight during the first half of the month and about four hours before it during the second half. It becomes retrograde on 13th. It is in Cancer (*Karkata*. Its visual magnitudes varies from -0.2 to -0.8.

Jupiter (Brihaspati) rises at about sunset and sets at about sunrise during the month. It is in opposition to the sun on 23rd. It is in Gemini (*Mithuna*). Its visual magnitude is about -2.3.

Saturn (Sani) rises about one and a half hours before local midnight during the first half of the month and about two and a half hours before it during the second half. It becomes retrograde on 11th. It is in Leo (*Simha*). Its visual magnitude is about +0.6.

(*Source* : Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st Floor), New Alipore, Calcutta-700053).

MALARIA COMES BACK

NARENDER K. SATIJA

In the late sixties, malaria was thought to have been eradicated from India. But recently the disease has staged a come back in a virulent form

MALARIA is caused by a unicellular parasitic organism, *Plasmodium*, which invades certain tissue cells and the red blood cells. There are over 100 species of *Plasmodium* infecting a wide range of vertebrates, among which birds and mammals are the most important. Malaria is however produced in man by four species, each with its own pathology and distinctive symptomatology. *Plasmodium falciparum* causes malignant tertian malaria (occurring every second day) primarily in tropical areas. *Plasmodium vivax* causes benign tertian malaria and is the most widespread one. *Plasmodium malariae* is the cause of quartan malaria (occurring every third day). Its chronic infection is often associated with nephrosis (kidney damage). *Plasmodium ovale* causes tertian malaria. It is uncommon and is observed most frequently in Africa.

History

Present in tropical and subtropical areas since time immemorial, malaria has been recognized in India in the Vedic medical literature as the "King of Diseases", and was often attributed to the wrath of Lord Shiva. The Chinese differentiated tertian from quartan fevers and noted the enlargement of the spleen. In the book, *Man's Mastery of Malaria*, Hippocrates has been described as the first malariologist. Recognizing very correctly the relationship of the ecological conditions with the disease, Hippocrates wrote:

> "Should there be rivers in the land, which drain off from the ground the stagnant water and the rain water, there (the people) will be healthy and bright. But if there be no rivers, and fenny, the physique of the people must show protruding bellies and enlarged spleen."

The causative agent of malaria, *Plasmodium*, was unknown until 1878 when Charles Louis Laveran, a French army surgeon stationed in Algeria, showed the parasite under a microscope after spending much of his time looking at unstained preparation of the blood of malaria patients. Sir Ronald Ross, a British physician in India who worked first in Secunderabad and then in Calcutta, discovered the development of malarial parasites in *Anopheles stephensi* in 1898. He also discovered the life cycle of the parasites. He found that the parasites were directly transmitted by female *Anopheles*. Genus *Anopheles*, which alone is capable of transmitting human malarial parasites, has a variety of habits among the different species.

Pyrethrum and kerosene sprays were used to kill the larvae and adult mosquitoes. The advent of DDT (dichloro-diphenyl-trichloro

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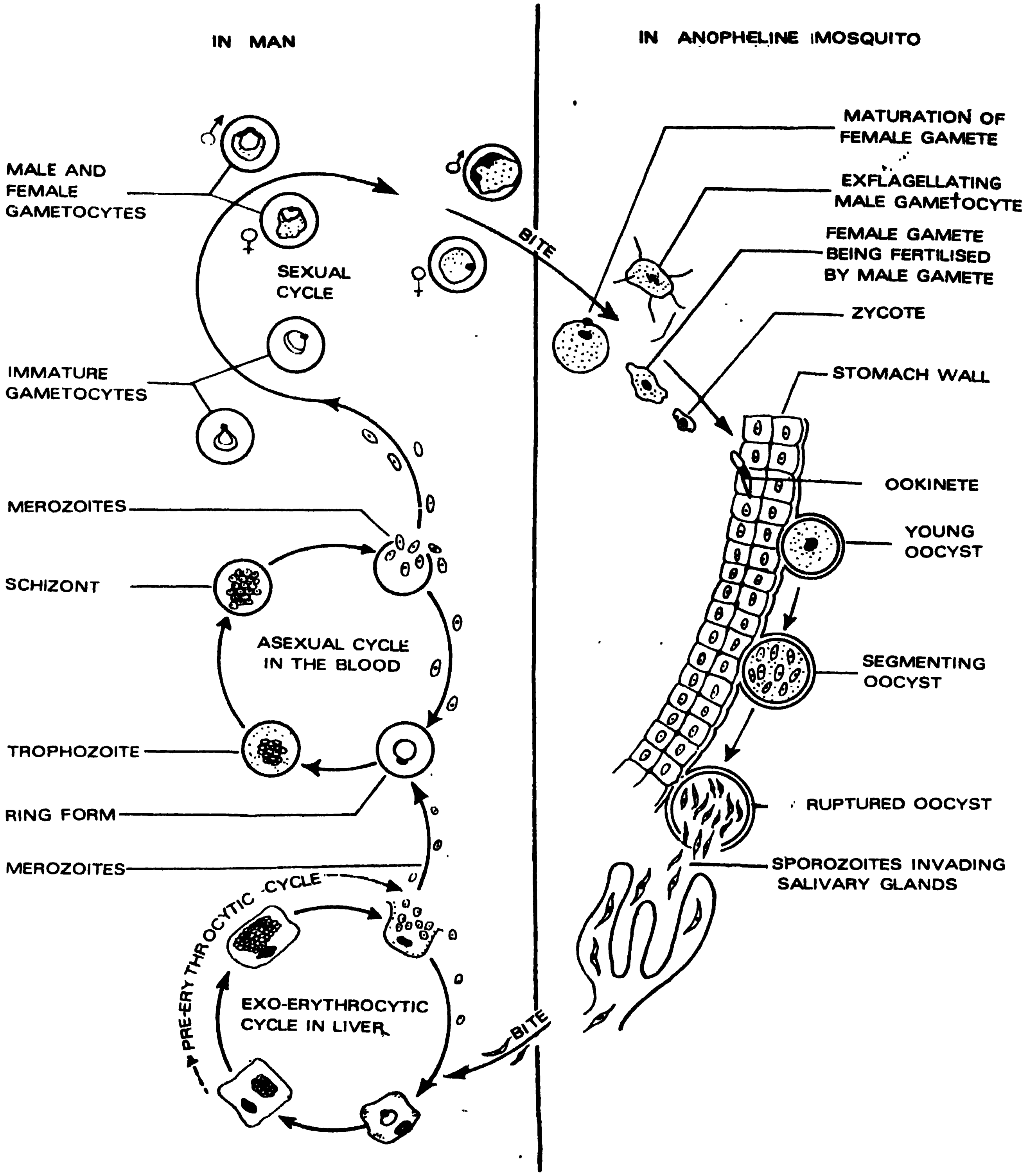
Shri Satija is a researcher at Defence Institute of Physiology and Allied Sciences, Delhi Cantt. 110010



IN MAN
IN ANOPHELINE MOSQUITO
MALE AND FEMALE GAMETOCYTES
♂
♀
SEXUAL CYCLE
IMMATURE GAMETOCYTES
MEROZOITES
SCHIZONT
ASEXUAL CYCLE IN THE BLOOD
TROPHOZOITE
RING FORM
MEROZOITES
PRE-ERYTHROCYTIC CYCLE
EXO-ERYTHROCYTIC CYCLE IN LIVER
BITE
BITE
MATURATION OF FEMALE GAMETE
EXFLAGELLATING MALE GAMETOCYTE
FEMALE GAMETE BEING FERTILISED BY MALE GAMETE
ZYCOTE
STOMACH WALL
OOKINETE
YOUNG OOCYST
SEGMENTING OOCYST
RUPTURED OOCYST
SPOROZOITES INVADING SALIVARY GLANDS

Fig. 1. Reproductive cycle of the malarial parasite *Plasmodium vivax*

ethane) synthesized first in 1874 brought new hopes for malaria control. But its widespread use during World War II suppressed its effectiveness. DDT spraying as a method of eliminating the infected vector for preventing malaria transmission led to a decreased emphasis on permanent species control, the basic procedure in operation before 1945. When the World Health Organisation initiated a campaign to eradicate malaria by insecticides, some success was achieved in freeing many parts of the world from the disease. This was due to the elimination of unstable malaria—a disease varying greatly in its year-to-year prevalence. But stable malaria is prevalent throughout the year as a disease of tropical areas, because of continuous interaction between the increased immunity caused by repeated infection of the host and the highly reproductive parasite population. So eradication as yet has not been economically feasible throughout the world. Malaria was almost brought under control in India a few years ago. At that time, there was hope that malaria could be eradicated from India. But soon such hopes were shattered and malaria came back rapidly throughout the country.

Life cycle

The life cycle of the malarial parasite is the key to the spread and persistence of the disease in a population. There are three phases: two in the human host, one in the mosquito. The human phases for *P. vivax* are shown in Fig. 1.

Man is infected by sporozoites injected by the bite of an infected mosquito. There is a very brief period of about half an hour during which the parasite may be found in the blood. It rapidly disappears from circulation, and during the next 7 to 10 days gets localised in the parenchymal cells of the liver. Then the sporozoites gradually grow into enlarged cysts containing over 10,000 merozoites in *P. vivax* and 40,000 or more in *P. falciparum*. This constitutes the pre-erythrocytic stage of the cycle during which the subject remains symptoms-free. On reaching maturity, merozoites are released from cells of liver and enter red blood cells (erythrocytes) to start the blood cycle. When erythrocytes burst, the liberated merozoites are capable of infecting more red blood corpuscles and the multiplication continues. It is this periodic breaking of erythrocytes that causes the characteristic chill and fever, every second day in tertian and semitertian malaria and every third day in quartan malaria. The fever following the chill is due to the liberated foreign protein, globin, and other cell products. For reasons not

Of relapses—alternative hypothesis

In malaria relapses may occur months or even years after initial infection. It was earlier thought that during remissions, parasites persisted in blood and their spasmodic appearance were not true relapses but recrudescences. Discovery of the exoerythrocytic stages in liver in 1948 suggested persistence of parasites in liver from where they flooded blood at times. Recent work in the Soviet Union and Romania does not support this theory, instead suggests the old one.

The tertian malaria parasite, *P. vivax*, has been suspected for quite sometime to exist in two forms, one, with a latent period (period between infection after mosquito bite and appearance of parasite in the blood) of 13 to 16 days; second, with a less defined, longer, latent period of 300 days or more.

The form with shorter period is characteristic of tropical strains while the other is found in more temperate regions, such as Soviet Union and North Korea. Last year a team of nine researchers demonstrated the coexistence of sporozoites capable of inducing short or long periods. In parallel experiments, a tropical strain of *P. vivax* used had only a short period (12 to 17days).

The experiments suggest that in temperate strain of *P. vivax*, there are atleast two genetic types—one with long latent period and the other with short latent period. In any population of sporozoites, those with "long latent period" outnumber the ones with "short latent period". Of the tropical strain of *P. vivax* perhaps the reverse is true. The cause of the difference in latent period in temperate and tropical strains is presumably due to differences in the seasonal availability of suitable mosquitoes for transmission.

According to E.E.G. Cox (*Nature*, vol. 266, 1977, pp. 408-409) "there is no need to postulate a continuous series of exoerythrocytic cycles to account for relapses, because they could result from initial infection with sporozoites having prepatent periods of up to several years." For irregular relapses characteristic of malaria, Cox points out difference in the time for the maturation of different sporozoites into exoerythrocytic stages as the cause.

Continuous exoerythrocytic cycles are not believed to occur now in any human species of malaria. In *P. vivax* and *P. ovale*, relapses are due to long and varied development of sporozoites. In *P. falciparum* and *P. malaria* small numbers of parasites continue to exist in blood after initial infection. Subsequent attacks, therefore, are not true relapses, instead they result from recrudescence of the parasites existing in the blood.

Z. I.

yet understood, some of the merozoites invading erythrocytes fail to repeat this cycle and differentiate into male and female gametocytes. No further development of these forms occurs until blood is ingested by a female mosquito during the bite. In the gut of the mosquito, the male gametocyte gives rise to male gametes and the female gametocyte to female gametes. Now fertilization takes place resulting into a zygote which develops in the gut wall of the mosquito, eventually giving rise to the infective sporozoites.

Pathogenicity

Malarial parasites vary greatly in host specificity, the pattern of exoerythrocytic schizogony and in pathogenicity. The important differences among various infections are summarized in Table 1. Malaria may show a widely varying clinical picture and may, especially in the malignant tertian form, simulate other diseases with the result that diagnosis and adequate treatment is delayed. The basic pathological processes include the destruction of ery-

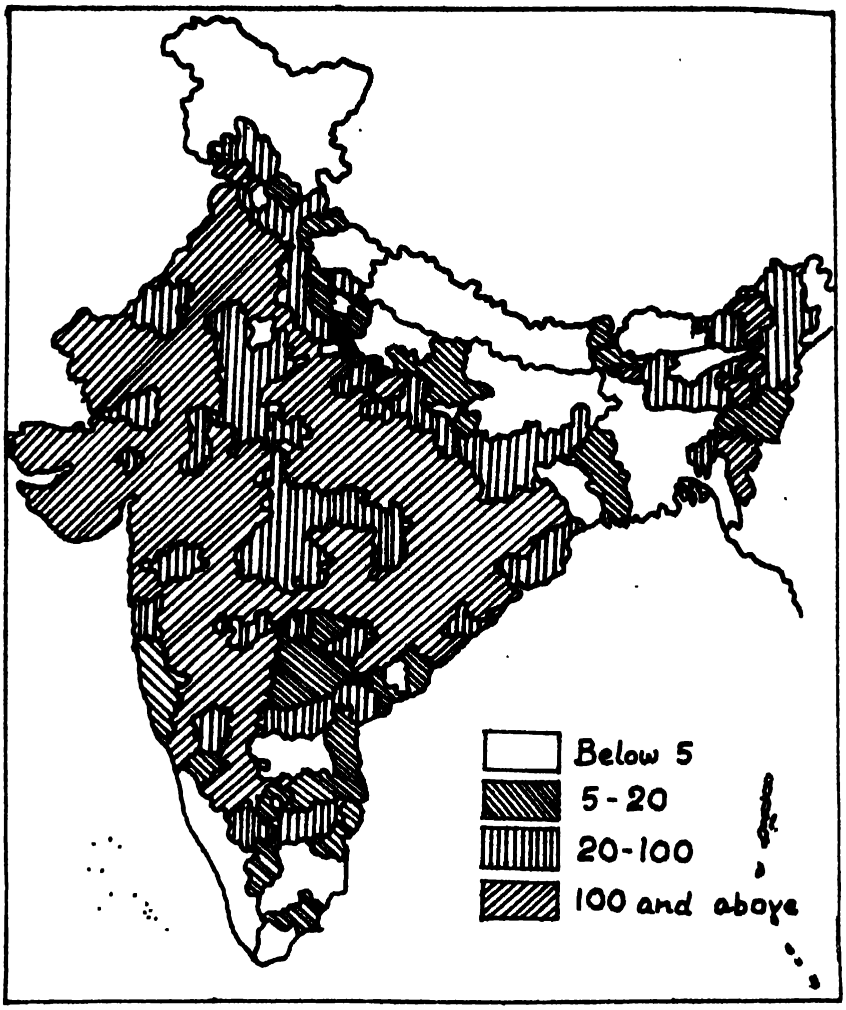


Fig 2. Incidence of malaria in 1975 (per thousand population)

Table 1. Characteristics of representative malarial parasites

Species	Host	Erythrocytic Cycle		Outcome
		Periodicity (Hours)	Degree of synchrony	
P. fall	Turkey	Unknown	Low	Death
P. laphurae	Duck	36-48	High	Mortality variable
P. berghei	Mouse	24	Low	Death
	Young rat	24	Low	Mortality variable
	Mature rat	24	Low	Resolution
P. yoelli	Mouse	24	Low	Resolution
P. knowlesi	Rhesus monkey (*Macaca mulatta*)	24	High	Death
	Kra monkey (*M. fascienlaris*)	24	Moderate	Chronic
P. falciparum	Man	48	Moderate	Mortality variable
	Owl monkey (Aotus trivirgatus)	48	Moderate	Mortality variable
P. harasilianum	Squirrel monkey (Saimiri sciurens)	72	—	Chronic
P. malaria	Man	72	Moderate	Chronic
	Owl monkey	72	Moderate	Chronic
P. viva	Man	48	Moderate	Relapsing
	Owl monkey	48	Moderate	Chronic
P. ovale	Man	48	Moderate	Relapsing

Table 2

Drug	Duration of treatment (Days)	Half life (Hours)
Chloroquine	3	120
Primaquine	5	—
Pyrimethquine	2	96
Quinine	6	10
Tetracycline	3	9
Proguanil	3	—
Mefloquine	1 dose	
Clindamycin	3	2

throcytes and the production of a pigment haemetin and toxic damage to various tissues. In falciparum malaria, mechanical blockage of the small blood vessels with parasitized erythrocytes may result in anemia, hyperbilirubinaemia (presence of large amounts of bilirubin in blood), hypoxia or anoxia (deficiency of oxygen in tissues and organs) etc. After the onset of symptoms, the three main types of malaria differ considerably. Falciparum malaria is a sudden, severe disease killing children and non-immune adults alike. It has a 48-hour developmental cycle but the individual parasites are poorly synchronized so that chills and fever may come at irregular intervals. Secondly, as the parasite matures within the RBCs, the red cells tend to stick to the capillaries and produce sludging resulting in cerebral malaria, biliary remittent fever, algid malaria (shock), cardiac complications and even acute pulmonary edema. When destruction of RBCs is extensive, hemoglobinemia (free hemoglobin in blood plasma) and hemoglobinuria (hemoglobin in urine) follow. Death in falciparum malaria is due to one or more of the above complications. Falciparum malaria has little tendency to recur. Vivax malaria is more common. In this, after the initial period, there is a cycle of 2 days. It is more benign, for it does not parasitize cells indiscriminately. In contrast to falciparum malaria, death rarely occurs from the infection. Relapses are frequent but can be easily treated. Quartan malaria differs from the other two in that it is far more persistent, and the parasite is apparently able to remain in the blood at subclinical levels for years after the first attack. Blood transfusion from a donor exposed to it some decades ago has been known to cause quartan malaria in the recipient. Acute attacks, in a 72-hour cycle, may be produced by two or even three different generations of parasites resulting in albuminuria (albumin in urine) and other symptoms of nephrosis. It is believed that glomerular damage, which is the cause of nephrosis, is mediated by malarial antigen-antibody complexes trapped in the glomeruli (bunches of blood capillaries in kidney tubules). Immunofluorescence studies of renal tissue of children with this syndrome in Nigeria showed not only bound immunoglobulins, primarily IgM, but also IgG and IgA. Recently, radioimmunological techniques have been used successfully for their detection in sera from infected persons and infected monkeys.

The spleen plays an important role in the defence of the host against malaria, as splenectomy invariably

Resistance to chloroquine

THE bitter quinine compound that we take during an attack of malaria may prove ineffective at times, because some strains of *P. falciparum* are now resistant to this drug. The resistance varies from occasional loss of the effect of chloroquine on asexual stages of the parasite to a complete loss in severe infection.

In cases of sensitive strains (S) chloroquine clears asexual stages of the parasite within seven days of initiation of treatment with no subsequent relapse. In a low degree of resistance (R_1), though the drug initially clears the asexual stages, revival occurs due to some of the plasmodia left unaffected during the course of treatment. Though there is a marked reduction in population of the parasite in moderate type resistance (R_2) clearance does not occur. High order resistance (R_3) is marked by no reduction in asexual stages after the start of treatment.

The task of classifying different strains (R_1, R_2, R_3) is a difficult one. The major difficulty however, is with R_1 type of resistance. This is of great practical importance because it indicates the beginning of resistance and, therefore, it may be often confused with reinfection at places where active transmission of the disease is prevalent

In India, drug resistance in *P. falciparum* has already been identified or strongly suspected in districts on the southern banks of Brahmaputra in Assam, Meghalaya, Tripura, Mizoram, Manipur, Nagaland and Arunachal Pradesh. Task forces and the expert committee which met recently at the Indian Council of Medical Research, New Delhi, recommended that monitoring teams should be deployed at places where resistance has been detected and in those areas where *P. falciparum* incidence is high.

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Table 3. Statewise malaria incidence for the years 1974 and 1975 (January-May)

State	1974	1975
Haryana	54,849	1,12,944
Himachal Pradesh	2,173	2,709
Jammu & Kashmir	1,673	2,136
Punjab	48,562	67,647
Uttar Pradesh	35,317	85,096
Chandigarh	333	1,235
Delhi	2,323	9,285
Assam	23,897	36,657
Bihar	19,555	16,348
Manipur	231	271
Meghalaya	1,333	1,470
Nagaland -	1,119	218
Tripura	1,228	2,052
West Bengal	5,403	5,682
Arunachal Pradesh	5,227	5,016
Sikkim	042	019
Mizoram	2,717	4,662

leads to recrudescence of latent infection Enlargement of spleen (splenomegaly) usually accompanies malaria infections and the increase in spleen size is used as an indication of malaria endemicity With the cure of malaria infection, the enlarged spleen rapidly returns to normal size.

The syndrome of enlarged spleen accompanying malaria is referred to as tropical spleen syndrome (TSS It consists of persistent splenomegaly in adults, raised serum levels of IgM and a positive response to antimalarial therapy TSS is also frequently associated with lymphocytosis in the peripheral blood, bone marrow, and in hepatic sinusoids. Of the several hypotheses to explain the abnormally high production of IgM antibodies, the failure to switch from IgM to IgG antibodies after antigenic stimulation, malfunction of T (thymus-dependent) and B cell (bone marrow-derived) co-operation, release of a B cell mitogen of malarial origin, and abnormal reactions to the presence of immune complexes are the most favoured ones

Susceptibility to drugs

Drug effects may vary with (i) species of parasite, (ii) different stages of the parasite in the host, and (iii) geographical region in which the parasite resides. But it is beyond the scope of this article to explain these factors However, the following are of direct public health importance (1) resistant forms of *P. falciparum*, (2) the use of drugs in the prophylaxis of malaria, (3) mechanisms of drug resistance, and (4) the persistence of drug resistance in the parasite population in competition with drug-susceptible strains.

Although falciparum malaria responds well to chloroquine, partial resistance to it has been reported regularly Drug prophylaxis can be of use only when highly effective or when they produce a radical cure. The continued administration of partially effective drugs has no permanent effect in malaria control. But there is a theoretical possibility that the blank administration of a drug which affects most, if not all, stages of the parasite does contribute significantly to the eradication of malaria. For falciparum malaria such a drug was pyrimethamine. But the early emergence of pyrimethamine-resistant strain of *P. falciparum* in various parts of the world has made this compound less promising. Chloroquine and camaquin are used the world over to prevent or suppress clinical attacks.

Mechanisms of drug resistance are not adequately understood The cause of the prevalence of drug-resistant forms is also not clear However, some experimental studies on rodent malaria indicate that drug-resistant forms may be more readily transmitted by mosquitoes

Immunity

Immunity is generally regarded as the capacity of an individual, when exposed to an infection, to remain free of clinically overt illness Adults in areas of intense transmission show relatively few parasites in their blood and the size of their spleen decreases with age despite continued exposure Experimental studies on humans showed that immunity against one strain of a species of *Plasmodium* obtained by continuous exposure did not protect against other species of *Plasmodium*.

From earlier works in different parts of the world, it is clear that some degree of immunity to malaria could be produced in experimental animals after vaccination with parasites in various ways, viz., parasitized erythrocytes, parasite fractions, merozoites, sporozoites etc. These methods have led to an appreciation of the multiplicity of possible approach to immunization of man. Recent work on human and animal malaria has shown that a number of antigens, about 15,

Cultivation of human malaria

WITH the conventional methods of controlling malaria becoming ineffective, attention is now being turned to develop a vaccine against malaria. Prerequisite to the development of a vaccine against malaria is successful *in vitro* propagation of the parasites. Recently this has been achieved by two independent groups of workers in the United States.

Malarial parasites have three distinct cycles of multiplication: the sporogonic cycle in the mosquito, and the exoerythrocytic and erythrocytic cycles in the vertebrate host. In the same species the parasites in each cycle are antigenically distinct. Effective immunity has been produced in experimental animals by the inoculation of parasites in any one of three stages, viz., sporozoites exoerythrocytic parasites (avian malaria), or erythrocytic form. Irradiated parasites, either erythrocytic form or sporozoites, have been particularly useful. There is now a large volume of recent work on vaccination with such material, including some promising results in man. Hence *in vitro* culture of any one of the three stages could theoretically provide material for immunization.

The *in vitro* culture of malarial parasites has been achieved for many years, but only one or a few successive cycles of development have been achieved. Moreover, these successes were mainly with the monkey's malaria parasites from which considerable biochemical and physiological information was gained. However, what is desperately required is the long term continuous cultivation of human malaria parasites which cannot be maintained in laboratory animals The cultivation of *P. falciparum* has now been achieved by William Trager and James B. Jensen of Rockefeller University, New York (*Science*, **193**:673, 1976) and J. David Haynes, Carter L. Diggs, Fred A. Hines and Robert E. Desjardins of Walter Reed Army Institute of Research, Washington, United States (*Nature*, **263**:767, 1976). The media in which the parasites are cultured are simple. Trager and Jensen maintained *P. falciparum* in continuous culture in human erythrocytes incubated in RPMI 1640 medium with human serum at 38°C under an atmosphere of 7% CO$_2$ and low O$_2$ (1 % or 5%). The original parasite material was obtained from an infected *Aotus trivirgatus* monkey. The parasites continued to reproduce in their normal sexual cycle of approximately 48 hours and the cultural parasites remained infective to monkeys. Haynes *et al.* cultured parasites in a supplemented medium 199 with 1% foetal bovine serum in an atmosphere of 3% CO$_2$ at 37°C. The parasites for culture were obtained from a splenectomised *Pan troglodytes* chimpanzee. The most important features of the cultivation techniques described seem to be the high levels of CO$_2$. Haynes *et al.* obtained eleven successive cultures and Trager and Jensen obtained more than twenty-five. The latter has since reported continuous cultivation over 105 days, implying fifty or more cycles. So there is no reason why such culture should not be maintained indefinitely.

Both the techniques look promising but Haynes *et al.* have made an advance by showing that their culture can be initiated in frozen blood samples also. This would save the lives of countless monkeys which are the only source of laboratory maintained *P. falciparum*. Further improvements in the culture of *P. falciparum*, in particular the production of a large number of merozoits (the stages that pass from one cell to another), should facilitate biochemical and immunological studies that may lead to an effective vaccine for malaria. A vaccine with real potential in monkey, at least, is based on merozoites (G.H. Mitchell, G. A. Butcher and S. Cohen, *Immunology*, **29**, 397, 1975) The production of a suitable vaccine free from viruses is possible only with cultured parasites.

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are present in the malarial parasite. Some of these antigens withstand heat, others are destroyed by heating. The relationship of these antigens to strain difference has not yet been determined.

Theoretically, immunization with sporozoites would seem most logical, since in nature, transmission occurs only by means of sporozoites. In rodent malaria, small doses of X-ray irradiated sporozoites have given absolute immunity against infective sporozoites. Immunity to *P. falciparum* was induced in 3 out of 5 human volunteers exposed to bites of irradiated infected mosquitoes.

Table 4

Age Group	Permissible dosage (MGS)	
	Chloroquine	Primaquine*
0-1	75	Nil
1—4	150	2.5
4-8	300	5
8-14	450	10
>14	600	15

*Daily single dose

Genetic interactions with red cell abnormalities

Population geneticists have long been puzzled by the high proportion of persistence of the deleterious gene for sickle cell anemia. Dr. A. C. Allison of the Clinical Research Centre of Medical Research Council, England, was the first to discover that there is an inverse correlation between the intensity of falciparum malaria and the presence of the sickle cell trait. The correlation in geographical distribution between the prevalence of malaria and a number of other abnormalities of red blood cells has led to the belief that they act as factors suppressing the spread of malaria. Perhaps the best example is the genetic abnormality of red blood cells responsible for hemolysis by a variety of chemicals, including plasmochin, pentaquine and favabean. This genetic abnormality, which may be detected by measurement of the enzyme glucose-6-phosphate dehydrogenase, does not cause any difficulty under normal conditions and thus might be quite effective in protecting the population. However, there is no clear indication as yet about the mode of action of any of these protective genetic factors. It has been proposed that the use of oxygen by the parasite leads to earlier sickling of the parasitized red cells, and thus to an earlier sequestration of the parasite in the capillaries, which in turn causes a reduction in the number of viable parasites. Other evidence indicates that those individuals who have the gene for sickling develop a higher level of gamma globulin than those without it.

This interrelation of two disease conditions, malaria and sickle cell, was the first clear demonstration of the interaction of population genetics and a disease.

Control and eradication

Eradication of malaria has not been feasible in most parts of the world. Temporary measures are useless and often damaging, because the reproductive potential of the parasites promptly returns the population to its original level, often with an increase.

The methods used in control and eradication may often differ not only in emphasis but also in actual technique. Since World War II, overwhelming reliance has been placed on insecticide spraying. This kills the adult mosquito immediately after she has fed on the malaria carrier, well before the parasite has had time to develop. Insecticides act as a means of isolating the source of infection. Recently, however, increasing numbers of genetically resistant anopheles of different species have appeared. This resistance may be either physiological due to an enzyme which destroys DDT, or it may be behavioural. Attempts have been made to limit the number of adult vectors by killing their larvae. Means to avoid mosquito bites by using mosquito nets, insect repellants, and wire nets across windows are good means of prevention of malaria.

Theoretically, malaria might be eradicated or greatly reduced by drug therapy alone. This theoretical possibility was first seized upon by Robert Koch in Germany, who proposed that massive administration of quinine would eliminate the disease. There are many drugs (Table 2) which can be given in proper dosage, but the choice of drugs for the prevention of malaria depends on the resistance patterns. Recently, mefloquine hydrochloride, a quinoline methanol, has been developed by US Army Malaria Research Programme (Canfield, C. J. and Rozman, R. S., *Bulletin of the W. H. O.*, **50**: 203, 1974). Given as a single dose, it was found highly effective in volunteers inoculated with *P. falciparum* (Trenholque, G. M. *et al.*, *Science*, **190**: 792, 1975). This drug is not yet commercially available

Present position in India

In the late sixties, malaria was thought to have been eradicated from India. It was then difficult even to show a human malarial parasite to medical students. From a bare one lakh cases in 1965, the incidence shot up to 51 lakhs in 1975. And though no death was reported in 1965 and only 3 in 1974, 99 people died of malaria in 1975. The statewise position of incidence of malaria for the years 1974 and 1975 (January-May) is shown in Table 3. WHO has forecast a steep increase in malaria incidence in India. There may be about 1-2 crore cases by the end of 1970's, with 25% of them due to *P. falciparum* of the virulent form, which can damage the brain.

Research in India

Attempts are being made to develop a vaccine against malaria at the National Institute of

(*Continued on page 696*)

OCEAN BASINS AND CONTINENTS —Are they permanent?

JAYANT KUMAR ROUTRAY

Ocean basins and continents have always been permanent and will remain so

CONTINENTS and ocean basins are two major relief features of the earth's surface. The nature and characteristics of these two features vary significantly and make a clear distinction between them. The permanency of ocean basins and continents may seem illogical to some earth scientists and geologists after the present findings in oceanography and plate tectonics. But even though some of the facts contradict the rule, it has been proved that the continents and ocean basins in a broader sense have been permanent through the ages.

Facts in favour of permanency

Sedimentary rocks on land are generally different from the muds that cover the deep ocean floor. Nowhere in the oceans have geologists been able to find crust resembling the continental crust in thickness or composition. Oceans and continents are presumably not interchangeable, the ocean floor does not rise above sea level like the floor of the epicontinental seas (a relatively shallow sea on the continental shelf), and continents do not simply sink into the ocean depths. It was therefore once thought that oceans and continents were permanent features.

Normally, sedimentary rocks are rare on oceanic islands, far removed from the influence of continental rocks. The oceanic islands are generally composed of either volcanic or coral reef materials. This suggests that ocean basins and continents existed in the past in the same areas where they are seen today.

The older geologists thought of ocean basins as relatively shallow troughs with sediments (muds, etc.) spread uniformly on the floor. But the form of the ocean basins plotted from the soundings carried out in the later part of the nineteenth century was found to be totally different. "The cross section of the broad abyssal trough, flanked by the rim-like continental shelves, might be linked to that of a soup-plate rather than a shallow evaporating dish". This form prevents accumulation of sediments on the ocean floor (the sediments which are derived from continental mass are deposited along the continental shelf or geosynclines, the weaker mobile zones of the continents). Over and

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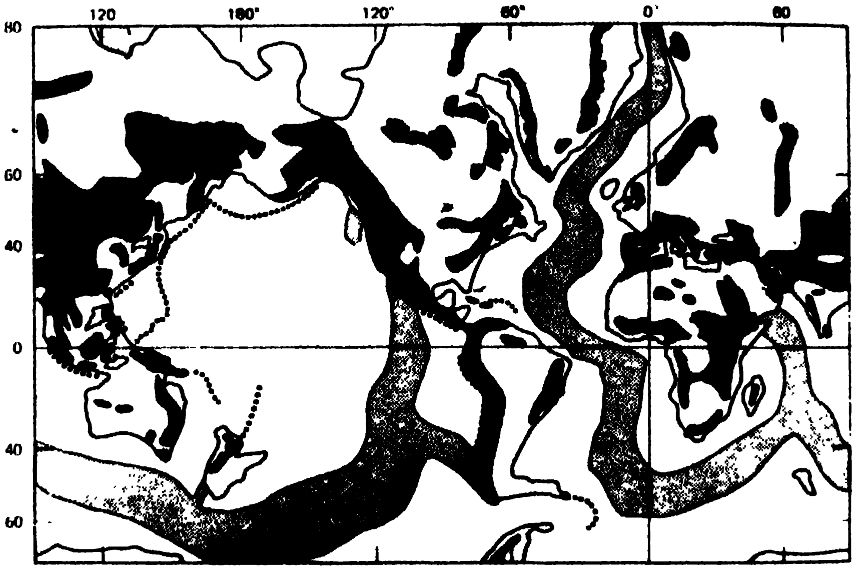

Fig. 1. Major structural units and physiographic features of the world: *Key*: White, abyssal ocean floor; medium shading, oceanic side system; heavy dotted lines, oceanic trenches; light shading, continental platform and continental shelf; dark gray, mountains, intermontane basins, associated hills and some elevated plateaus

above, regularity in form suggests that the ocean basins are free from disturbances and permanent through the ages.

The tetrahedral theory, propounded by Lowthian Green, a German scholar in 1875, suggested that the present pattern of continents and oceans is similar to the geometrical figure called tetrahedron. It was conceived that the earth is very much similar to a rough tetrahedron; a solid body bounded by four equilateral triangular surfaces. In this attitude, the four flat faces would represent the oceans, the Arctic Ocean corresponding to the upper horizontal face, the horizontal edges with land girdle round the Arctic basin; the three vertical edges with the north-south landmasses (Europe being conceived as separated from Asia, as it had been in the past); and the lower point with the Antarctic continent. J.W. Gregory has revived the hypothesis in recent years, stressing several well-known geographic homologies which support the theory, viz., excess of land in the northern hemisphere, triangular shape of the major geographical units, land units tapering southwards, oceanic units tapering northwards, general triradiate disposition of the landmasses in relation to the poles, and the antipodal position of land and sea.

The Baltic Shield, Laurrential Shield, Siberian Shield, Indian Table, Chinese Table and the continental landmasses of Australia, Africa, South America and Antarctica are areas underlain by Precambrian metamorphic rocks that have remained essentially stable since their last episode of metamorphism one billion or more years ago. Because of this apparent stability, they are thought to be extremely rigid and undeformable. This fact has led to the advocacy of 'the permanency of the continents'.

After the discovery of Mohorovicic discontinuity in 1909 by A. Mohorovicic, a seismologist, from the study of earthquake waves, seismologists seemed to confirm the notion that crust is fundamentally made up of two different kinds of rock materials. The discontinuity itself appears to be the boundary between the sialic rocks above and the simatic rocks below. The Mohorovicic discontinuity is at a general depth of 30 km to 40 km under the continents but may be as deep as 60 km under the roots of the major mountain chains. It is as shallow as 4 km to 5 km below the floor of the deeper parts of the ocean. The sial blocks constitute continents whereas the upper sima is the ocean basins. The density of continents varies approximately from 2.4 to 2.5. The rocks below Mohorovicic discontinuity have a mean density of 2.8 to 2.9. These facts suggest that the ocean basins cannot be drylands, nor the continents true ocean deeps. This means there is no

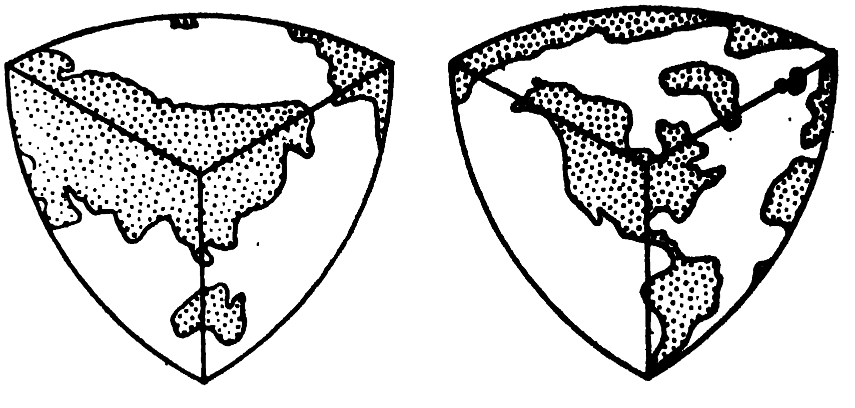

Fig. 2. The tetrahedral earth

question of reversal of the major relief features

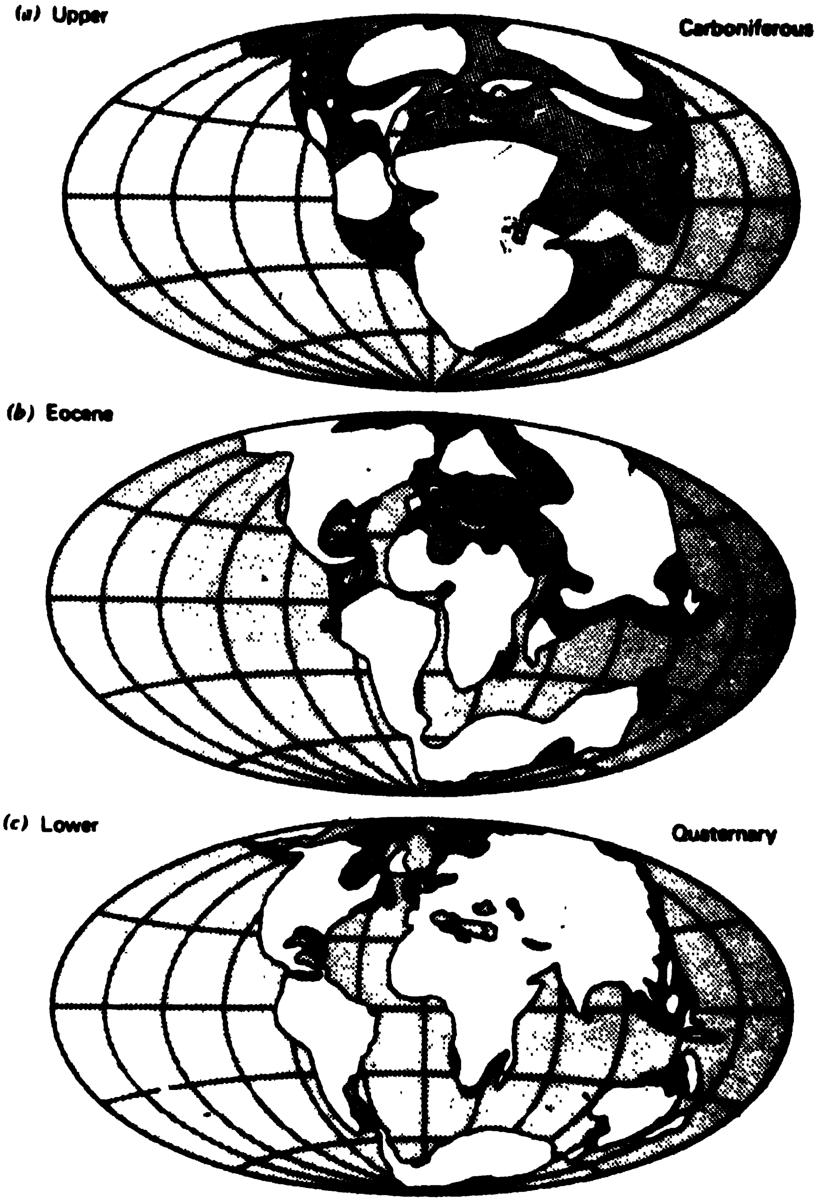

Fig. 3. Distribution of land and sea in different periods

Facts contradict permanency

Some observations, however, contradict permanency. The great thickness of sediments that accumulated in Palaeozoic times (which now forms the Appalachian mountains) seems to have derived from erosion of a landmass lying to the south-east which is now the Atlantic Ocean. Similarly the late Mesozoic sediments of the coast of California seem to have come partly from the west, and the nature of their metamorphism suggests that they may possibly have accumulated in what was once an oceanic trough. Still other landmasses might have existed where we now find oceans.

It should, however, be remembered that the process of mountain building is always associated with geosynclines (a long linear depression in the continental shelf) which are the weaker and mobile zones of the earth's crust and are a part of the continents and not of the ocean basins. That is, mountain building is confined to continents. Though there is relative change in shape and size of the continents through the passage of time, continents and ocean basins do not loose characteristics of permanency. This particular criterion can easily be applied to all the young fold mountain chains of the world.

The most fundamental objection to the permanency comes from the German scholar Alfred Wegener's continental drift theory. The drift is postulated by the convection currents inside the earth and now supported by Plate Tectonics Theory of Dan Mckenzie and Robert Parker. (By late 1964, the stage was set at four widely separated institutions for the birth of the new theory of plate-tectonics. The four institutions were Cambridge University in England, Princeton University in New Jersey, Lamount Geological Observatory in Palisades, New York and Scripps Institution of Oceanography in La Jolla, California. The two famous exponents, Dan Mckenzie and Robert Parker, were attached to Cambridge University and Scripps Institution of Oceanography respectively).

According to the drift theory, all the landmasses were concentrated at a point and named Pangaea. The present development and distribution of landmasses started from that giant landmass.

Fig. 3 represents the distribution of landmasses from upper carboniferous to older quaternary period. It is evident that the shapes of the continents at present are very much similar to the previous ones if we neglect the minor changes. So, even if the drift is true, the conti-

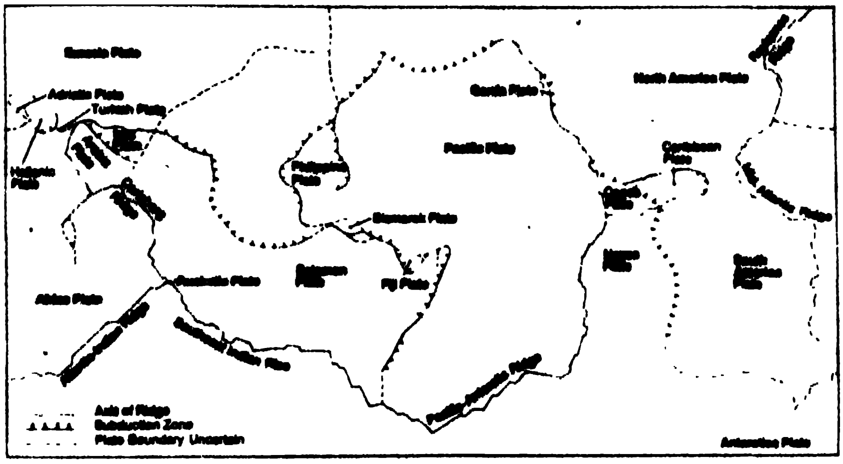

Fig. 4. Global lithospheric plates

nents have not lost their permanancy because they were present throughout the geological ages, though at different places. Secondly, permanent does not mean static. Although the continents are not static they are permanent. The continents are floating over a denser substratum (ocean basins) without losing their nature, characteristics and permanancy.

Mckenzie and Parker's Plate Tectonic Theory is now a much debated topic in the field of geomorphology. It solves most of the problems of different concepts like continental drift, geosyncline, mountain building and isostary, etc., and at the same time lends forceful support to the theory of permanency of ocean basins and continents. According to Plate Tectonic Theory, the continents are great rafts of rock supported from below by layers of denser plastic rock and the earth's crust is divided into a number of thin lithospheric plates. The earth's internal energy moves the plate horizontally by thermal convection current set up by radioactive heating in the earth's mantle. This particular plate tectonics phenomenon is very much similar to the continental drift.

A safe and positive conclusion can be drawn regarding the permanency of the ocean basins and continents after considering the facts which contradict the hypotheses. The continents and ocean basins were permanent and will remain so but there will be a change in space with respect to time The tetrahedral theory assumes a static position of the continents and ocean basins. while Wegener's theory supports the drift. None of them goes against the fact that there are two major features of the earth's crust, i.e., ocean basins and continents. One can say without hesitation that continents and ocean basins are permanent

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MALARIA *(Continued from page* 692)

Communicable Diseases, Delhi and at the Post-graduate Institute of Medical Education and Research, Chandigarh.

Research on development of antimalarial drugs from indigenous plants is also going on. The development of a vaccine will mean a breakthrough in the management of this disease. The results obtained on rats and monkeys using liver and blood antigens have shown about 90% protection. Other experiments which have shown 100% protection against malarial infection in rats, involved transfer of Kuppfer cells from the infected liver.

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L. P. DIXIT

PLASMA : THE FOURTH STATE OF MATTER

Many benefits can be obtained from matter in plasma state. The most promising is the possibility of inexhaustible energy supply

PLASMA has now been recognised as the fourth state of matter. The plasma state of matter is, however, not as much encountered in day-to-day life as the solid, liquid, or gaseous states. Intrinsic properties of the solid, liquid and gaseous states of various substances have been thoroughly studied in the past. Behaviours of substances of interest in these states under various external force fields, e.g., electric or magnetic fields, have also been extensively investigated. In fact, the record of properties and their interactions with external influences constitute a part of the voluminous scientific literature.

Of late, it has been realized that matter can also exist in another state called plasma, different from the well-known solid, liquid and gaseous states. It is estimated that more than 99 per cent matter in the known universe is in the plasma state. The lightning which accompanies thunderstorms is a vivid example of plasma. The aurora borealis provides an impressive plasma display in the earth's upper atmosphere. Solar flares, solar prominences and sunspots are the other spectacular plasma phenomena. In fact, all stars are themselves largely in the plasma state and so is the interstellar space.

What is plasma?

Plasma is conglomeration of mobile, positively and negatively charged particles; there is approximately the same particle density of positive charges as that of negative ones. Both the groups of charged particles need not necessarily be mobile; one group, say, positively charged particles, like the positive lattice ions in a metallic solid, may be stationary. The particles, atoms or molecules, may be singly or multiply ionized. An atom or molecule with one electron stripped off is called singly ionized; similarly, an atom or molecule with more than one electron stripped off is known as multiply ionized.

Plasma may also contain neutral atoms or molecules. An important parameter is the degree of ionization—the percentage of the gaseous atoms or molecules present as charged particles. When plasma contains neutral atoms or molecules, the degree of ionization is less than one. It is closer to unity when plasma is strongly ionized and almost zero when it is weakly ionized. Sometimes, multiply ionized atoms or molecules account conventionally for a degree of ionization greater than unity.

If plasma departs from the charge neutrality, that is, $n_i - n_e$ is not equal to 0 (n_i is the particle density of positively charged particles, and n_e is the particle density of negatively charged particles and electrons), it would still display plasma properties provided the following two conditions are met :

(i) Physical dimensions of the plasma system must be much larger than the Debye radius r_D. (r_D is also called Debye screening length.) It is the distance over which the particle density of negatively charged particles is not equal to that of positively charged particles. It is given by :

$$r_D = \left(\frac{\epsilon_0 kT}{n_e e^2} \right)^{\frac{1}{2}} \quad \text{......(1)}$$

with ϵ_0 being the permittivity of plasma assumed to be equal to that of the free space, k is the Boltzmann constant, T is the absolute temperature of the plasma, and e is magnitude of the electronic charge.

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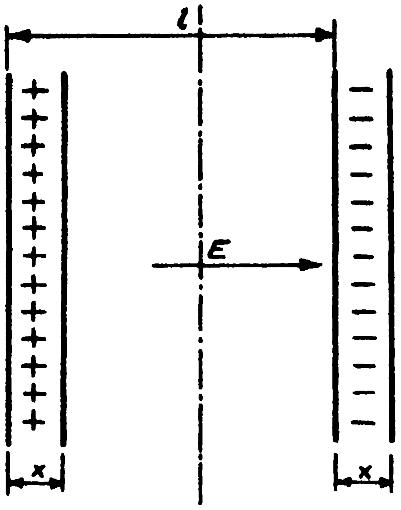

Fig. 1. A linear plasma departing from neutrality. The electrons are displaced by a distance x in the direction of one of the sides of the plasma slab of width l.

Within the Debye length, there exists a charge imbalance. So unless the overall dimensions of plasma are much greater than this length, the collective effects will not dominate the random individual particle's behaviour and the system will not exhibit plasma characteristics. In other words, the Debye radius is the smallest physical dimension of a plasma system. But how small can this be? It must, in fact, be much larger than the separation between two charged particles :

$$r_D > n^{-\frac{1}{3}}$$

where n is the particle density of the charged particles.

(ii) The characteristic plasma frequency ω_p should be greater than the collision frequency, ω_c .

Consider a plasma slab of thickness unity Suppose electrons are displaced by a distance x in the direction of one of the sides of the slab as shown in Fig. 1. At one end, the face has an excess of electronic charge ($-en_ex$) per unit area, and at the other there is an excess of positive charge ($+en_ix$) per unit area.

Under these circumstances, a force is developed in a direction opposite to that of the displacements of the net charges as shown in Fig. 1. Considering only electrons, because they react faster than positive ions due to their smaller mass, the balance of forces becomes :

$$F = -eE = -M_e\frac{d^2x}{dt^2} \quad \dots \quad (2)$$

E is the electric field generated by the charge displacement and M_e is the electronic mass. Poisson's law yields in one dimension.

$$E = -e\frac{n_e x}{\epsilon_0} \quad \dots \quad (3)$$

Substituting for E from Eq. (3) into Eq. (2) and rearranging one gets

$$\frac{d^2x}{dt^2} + \left(\frac{n_e e^2}{M_e \epsilon_0}\right)x = 0 \quad \dots \quad (4)$$

Eq. (4) expresses an oscillating motion, with angular frequency

$$\omega_p = \left(\frac{n_e e^2}{M_e \epsilon_0}\right)^{\frac{1}{2}} \quad \dots \quad (5)$$

In other words the plasma will oscillate with a frequency $\gamma_p = \omega_p/2\pi$ (called the characteristic plasma frequency) around its equilibrium position. If collisions could be neglected, the oscillatory motion would continue indefinitely.

Positive ions, too, oscillate at the so-called 'ion plasma frequency'

$$\omega_{pi} = \left(\frac{n_i e^2}{M_i \epsilon_0}\right)^{\frac{1}{2}} \quad .. \quad (6)$$

where M_i is the ionic mass. It can be proved that the actual plasma frequency, taking into account both types of oscillations in phase opposition (that is, electrons and ions are simultaneously displaced in opposite directions by equal distances from their equilibrium positions), is

$$\Omega_p = (\omega_p^2 + \omega_{pi}^2)^{\frac{1}{2}} \quad .. \quad (7)$$

and as ω_{pi} is much smaller than ω_p' Ω_{pi} is approximately equal to ω_p.

To summarize, a plasma state can be characterized, in general, by four parameters : particle density, temperature, Debye radius and characteristic plasma frequency. The particle density and temperature are independent parameters, while the Debye radius and the characteristic plasma frequency depend on the magnitudes of charge and masses of the particles constituting the plasma. The various natural and laboratory plasmas represented in the above parameters are depicted in Fig. 2.

The fourth state

Can plasma, as defined above, be considered the fourth state of matter? It is well-known that when enough energy is added to a solid, it becomes liquid. With more energy the liquid in turn gets converted into gas. If more energy is added, with increasing kinetic energy of the molecules, molecular impacts become so energetic that a fraction of the particles gets dissociated into electrons and the positive ions (positive ion is the residue of the molecule or atom which has been stripped of its electrons by one or more). The gas passes on to a state of matter called the plasma state

The physical properties of matter differ from one state to the other. The plasma state distinguishes itself from solid, liquid or gaseous state of matter in the following respects :

(i) Plasma state is the most energetic one; matter on an average requires 10^{-2} eV per particle (eV, read as electron volt, is a unit of energy and equals 1.602×10^{-19} joule) to change its state from solid to liquid or from liquid to gas, whereas a change of state from gas to plasma requires from 1 to 30 eV per particle, depending on the material.

(ii) The most notable feature of this state is that some of the particles, at least, are charged and therefore, interact with each other in accordance with Coulombs' law. The Coulomb-force is inversely proportional to the square of the distance between the charged particles and thus falls off very slowly with distance compared with most other interparticle forces. For example, the force between most neutral particles in a gas is large when the particle centres are within one diameter of each other, but very nearly zero when they are farther apart. So, in a plasma, every particle interacts simultaneously with many of its neighbours giving the plasma a cohesiveness which is often compared to that of a jelly. (In fact, the term plasma first made its appearance in biology in the word 'protoplasma', which was used to denote a 'jelly' type medium containing a large number of particles which make up the nuclei of the cells.) The cohesiveness of the plasma makes collective effects dominate over random individual behaviour of the particles, a feature very different from that found in gases.

(iii) Another distinguishing feature of the plasma state is that its charged particles tend to rearrange themselves in such a way as to effectively shield any electrostatic fields due either to some non-zero potential at surface or to a charge within the plasma. This rearrangement of the charged particles effectively cancels out any electrostatic fields within a distance of the order of a Debye length Plasma, as mentioned earlier, cannot exist unless its linear dimensions are greater than the Debye length There is no such limitation for any other state of matter.

(iv) Characteristic plasma frequency is another unique feature of matter in the plasma state. Matter cannot exist in this state unless the characteristic plasma frequency exceeds the collision frequency.

(v) The last but not the least distinguishing feature of a plasma state is the fact that it can co-exist in the same region of space with solid, liquid or gaseous state, a feature not found in the non-plasma states of matter. For instance, solid plasma includes metals like iron and tungsten, semi-metals like bismuth and antimony and semiconductors Mercury is an example of liquid plasma All ionized gases are, of course, gaseous plasmas.

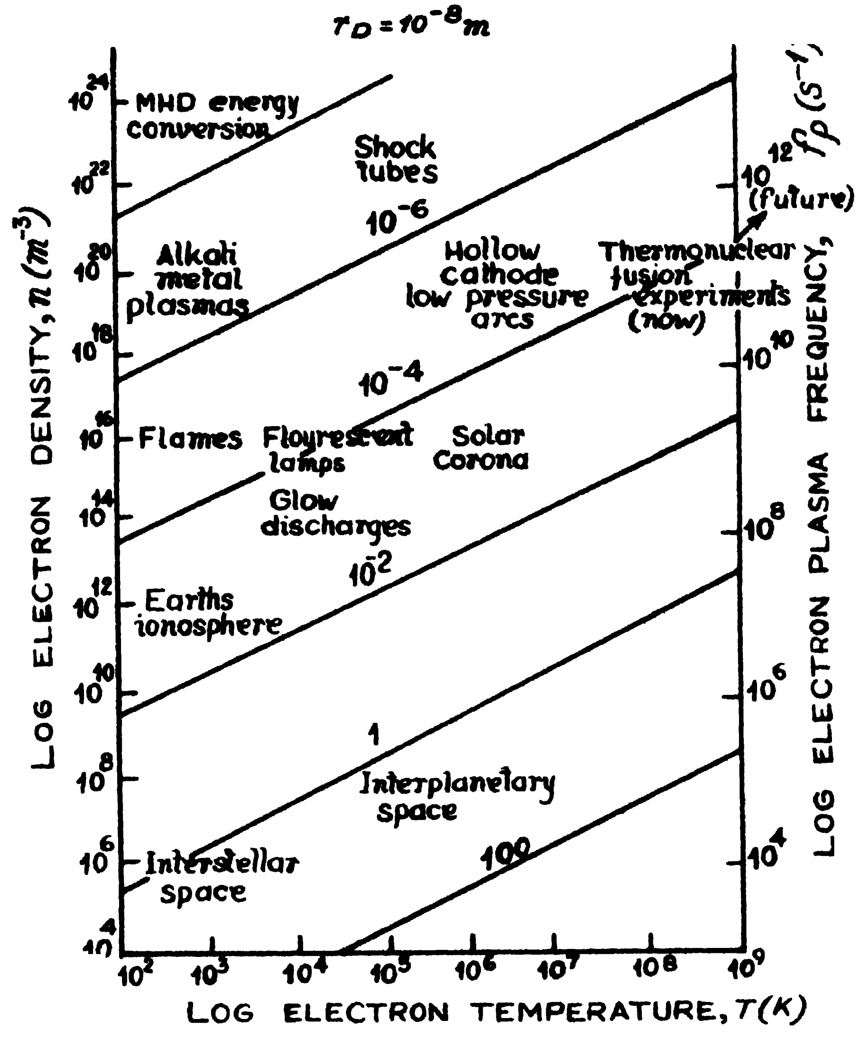

Fig. 2. Natural and laboratory plasmas represented in terms of n, t, the Debye radius and the electron plasma frequency

The plasma state is unique among the classical states of matter in that (i) it interacts internally with itself as well as with the externally applied fields and forces; and (ii) it can support numerous spontaneous (thermally induced) and externally induced oscillations and instabilities.

Applications

The investigations of the properties of plasma have disclosed immense potentialities of its exploitation for the benefit of mankind. Impressive amounts of energy are released in a thermonuclear reaction. (An exploded hydrogen bomb is a thermonuclear reaction out of control.) If these reactions were slowed down, the released energy could be useful to man. In a thermonuclear reaction the energy is given out because the mass of the products of fusion is less than the sum of the masses of the original isotopes (see *S.R.*, June 1977, **Quest for fusion power**). Specifically, two atoms of heavy hydrogen, deuterium (D) fuse to produce helium He , and neutron, *n*, or an atom of tritium (T), another isotope of hydrogen, and proton and a vast amount of energy as shown below (MeV stands for million electron volts)

$$D+D \begin{cases} \rightarrow {}^{3}He + n + 3.2\ MeV \\ \rightarrow T + p + 4.0\ MeV \end{cases}$$

$$D+T \rightarrow {}^{4}He + n + 17.6\ MeV$$

(*Continued on page 738*)

IRON OXIDE PIGMENTS
—The Versatile Colorants

V.V. RAMA SASTRY

Iron oxides are a group of important pigments wherefrom one can choose a wide range of colours or shades

COLOURS have aroused interest and curiosity in man since his earliest days. In course of time, he has learnt to make use of coloured materials, also known as pigments, for both decorative and protective applications in home as well as in industry. It is well recognised today that wood and metal surfaces can be painted with suitable pigments to provide hard and impervious films that resist weathering and impart superior protection. Pigments also find applications as paints and enamels on glass and ceramics and in interior decoration of walls, floors, furniture, etc. In addition, they are used in the manufacture of paper, printing and writing inks, linoleum, cosmetics and leather goods.

Colouring materials

To be effective in all these applications, apart from aesthetic appeal coloured materials should possess some important characteristics like opacity, hiding power, durability, preservative action, and permanence of colour A paint is manufactured by making a suspension of the pigment in a drying oil like linseed oil, which can form a protective film through oxidation and polymerization processes. Paints also contain thinners like turpentine which serve as volatile solvents for the drying oils. In order to accelerate drying of the film, compounds like napthenates and resinates of cobalt, manganese, lead or zinc are added to paints.

Natural iron oxides—the oldest colouring materials

Iron oxides constitute an important sector of inorganic pigment industry. The early applications of iron oxides as colouring materials were probably a consequence of their relative abundance in nature. Natural iron oxides constitute a significant portion of the solid part of the earth (lithosphere) and were probably the first colouring materials known to man. They were used by ancient Egyptians and Greeks thousands of years before the Christian era A cave painting of a Bison near Atlanta, Spain is believed to have been made with coloured iron oxide pigments during the Magdelenian period (16,000 B. C.). The retention of colours during the subsequent passage of time undoubtedly represents the longest successful resistance of coloured pigment to fading and atmospheric attack on record.

Apart from low cost, natural iron oxides have two outstanding characteristics—permanency against fading and good hiding power. These pigments are commonly designated in terms of their geographical ori-

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gin. Persian Gulf red oxide is produced from hematite deposits mined on Ormuz Island in the Persian Gulf; Spanish oxide from the red hematite deposits near Malaga, Spain; Turkish umber from Cyprus; and raw sienna from Sienna, Italy.

Today, all natural iron oxides are processed from any of the four types of iron ore—hematite, limonite, siderite and magnetite. A variety of colours and shades of iron oxides are available, but principally red, yellow, orange, brown and to a certain extent black colours are of commercial importance. The processing consists essentially of four steps; (a) grinding of the ore to reduce particle size and removal of unwanted impurities, (b) drying to remove moisture, (c) calcination to dehydrate hydrated iron oxides or to bring about a chemical reaction, and (d) micronising or conventional grinding to get the final product.

Modern pigment processing equipment is remarkably efficient and today's natural iron oxide pigments are far superior in fineness and pigment texture to the best powders that were previously obtained. This has been made possible by the advent of micronizer and as a result natural iron oxide pigments have remained in the market, though in a small way, in spite of the competition from the synthetic grades.

Synthetic iron oxides are superior

Although iron oxides are widely distributed throughout the world, all deposits do not merit processing to a pigment form. This is mainly because of the associated impurities and lack of acceptable colour and brightness. In addition, consumers do not have much choice of the quality and availability of required grades and shades of the pigment. So, over the last five decades, techniques have been developed for the production of synthetic iron oxides. For this, the availability of large quantities of waste iron salt solutions, particularly from ferrous metal pickling operations, was an important factor. Advanced countries started using these pickle liquors for producing high quality pigments—simultaneously combating pollution and waste disposal problems.

The main advantage of synthetics is that they can be tailor-made to the requirements and offer a reliable source regarding purity and availability.

Synthetic reds

Iron oxide red or red oxide is very stable and is unaffected by weak acids or alkalies and temperature. Other iron oxide colours finally change to red on heat treatment. There are three major methods of producing synthetic red oxides: (a) calcination of ferrous salts, (b) precipitation of ferrous hydroxides and their subsequent oxidation, and (c) calcination of yellow or black iron oxides. In all these methods, depending upon temperature and oxidation conditions, various shades ranging from tile red to maroon may be obtained.

Roasted copperas reds, chemically represented as Fe_2O_3, are obtained by calcining ferrous sulphate heptahydrate ($FeSO_4$, $7H_2O$), usually called copperas. The copper as required for this purpose is obtained from the ferrous sulphate liquors from pickling plants or from titanium dioxide plants using the sulphuric acid route. Pure iron is added to these liquors to precipitate ferrous sulphate which is then purified by recrystallization. The iron oxides obtained from such high purity copperas solutions contain very small amounts of impurities and are used in cosmetics, rubber and food packaging.

Spherical particles, more uniform in particle size and shape, are obtained from ferrous sulphate or ferrous chloride solutions, by first precipitating ferrous hydroxide and then oxidizing it under suitable conditions in the presence or absence of seed crystals. In these reactions, the pH of the medium is very important. As the particles grow in size they change in colour too; for example, from light tile red to dark maroon.

Ferrite reds are obtained by dehydrating synthetic yellow iron oxide under controlled conditions. These reds differ from calcined copperas in that the particles are acicular rather than spheroidal in shape. Shades of ferrite reds depend on particle size. Lighter shades are obtained from fine particle size yellows by calcination at a relatively low temperature, whereas darker reds are derived from darker yellows.

Synthetic yellows

Chemically, yellows are hydrated ferric oxide (Fe_2O_3, H_2O) and are normally produced by precipitation from iron salt solutions of waste pickling baths. The general method of manufacture consists of aerating ferrous salt solutions at elevated temperatures in presence of iron scrap and seeds for nucleation. The scrap iron acts as a buffer as well as additional supplier of ferrous salt by reacting with the sulphuric acid liberated in the process. Initially light yellow shades appear because of small size of the particles. As particles grow in size, yellow shade gains in intensity and finally turns red. The reaction is stopped at the desired shade. The precipitate is then washed and dried to get the yellow pigment.

Synthetic blacks and browns

Black iron oxides correspond to the general formula $FeO.Fe_2O_3$ that contains iron both in the ferrous and ferric states. The FeO content in the commercial grades usually varies and is responsible for the various shades of the material. Synthetic magnetites in general contain about 19%-22% of FeO. When FeO content is lower, various shades of brown are produced.

Black iron oxides can be produced under controlled conditions by either reducing synthetic red oxide or by oxidation of ferrous hydroxides obtained from ferrous salt solutions. The oxidation in the latter method is arrested at an appropriate ratio of FeO/Fe_2O_3 to get the desired colour. Brown iron oxides are sometimes produced by physically blending red, yellow and black iron oxides in suitable proportions to yield the desired shade.

Applications

Red oxides. Red oxides, natural as well as synthetic, are highly stable under conditions encountered in common applications. They are unaffected chemically or physically by sunlight and moisture and do not react with other materials like solvents, oils or resins used in paints. Iron oxide pigments have good to excellent hiding power, and being strong absorbers of ultraviolet light, protect the binders into which they are incorporated in surface coating applications.

Paints, suitably pigmented with natural red iron oxides, impart superior protection to both wood and metal surfaces at a relatively low cost. As their resistance to alkalies is outstanding, they are best suited for pigmentation of cementicious products and concrete structures. Natural red oxides also find extensive use in primers for automotive equipment, structural steel, ships and railway freight cars, because they are relatively low priced.

The synthetic red oxides are known for their excellent bleed resistance, chemical and heat resistance, light fastness and low toxicity. They are extensively used for protecting binders in plastics, paint, paper and fiber composites from sunlight. Synthetic red oxides work well in nearly every plastic, rubber or fiber system without introducing problems of heat instability, chemical breakdown or incompatibility. Synthetic reds of the copperas and calcined black type can be manufactured in a very pure form and are available for cosmetic and drug use because of little or no toxic metal contamination.

Yellow oxides. Ochres or raw siennas are natural yellow pigments. They as well as the synthetic varieties are not stable to heat and on calcination yield richly coloured red pigments. The natural varieties on heating give burnt siennas while the synthetics give ferrite reds. Applications of natural siennas are now limited to speciality uses such as wood fillers, stains and glazes where their relatively low hiding power is an advantage.

Synthetic yellows are known for their bleed resistance, chemical resistance, light fastness and excellent toxicity ratings. Synthetics have almost replaced natural varieties due to their clean and strong colours and lack of grit. The service life of paint and plastic compositions is prolonged because yellow pigments screen out ultraviolet radiation and prevent breakdown of polymers used. In addition, synthetic yellows provide a low cost hiding power and this can be profitably used in making various colorants. For example, browns are made by combining yellows with reds and blacks. Reds, oranges and greens may contain substantial proportions of synthetic yellows.

Another interesting application of yellow iron oxide pigments is based on their capacity of extending the more expensive organic colorants without distorting colour quality. A very important application of synthetic yellows after suitable transformation is as magnetic recording pigments. The transformed pigments find wide use in computer and video tapes and communications industries.

Brown iron oxides. The FeO content of common synthetic browns ranges from 1% to 10%. Pure synthetic browns possess very high tinting strength, excellent performance properties and outstanding chemical resistance. They find applications where these qualities are critical as in leather finishes, cement colours, furniture stains and finishes, trim enamels and floor paints. Paper, paper board and plastics intended for food applications such as candy box inserts or chocolate candy cups are commonly pigmented brown with the non-toxic, synthetic browns.

Non-colorant applications. Iron oxides have some non-colorant applications also. Because of their high surface area and other desirable properties, they find extensive use as catalysts, particularly for sulfur removal in petrochemicals and in the production of styrene, liquid hydrogen and solid rocket fuels. Iron oxides are also used for polishing metals and jewellery.

Conclusions

Iron oxides are a group of important pigments, wherefrom one can choose a wide range of colours or shades. They show outstanding pigment characteristics and are relatively low-priced. Hence they continue to be the preferred inorganic pigments in some of the important general and special purpose applications. The synthetic varieties are technically superior to natural ones and are made by using waste byproducts of industry. They aid pollution control and disposal of industrial wastes. Because of this, the synthetics have almost replaced natural oxides in most of the applications. However, natural pigments are showing a come-back in recent years because of the availability of micronized grades.

(Continued on page 738)

ACTIVE TRANSPORT IN BACTERIA

RAJENDRA PRASAD

In active transport, the solute accumulation is energy-dependent and against a concentration gradient

THE function of biological membranes including cell membranes and membranes surrounding subcellular structure was for a long time belived to be in the delineation of compartments, protection against loss of important substances and selection of certain penetrating molecules. This picture has fundamentally changed in the last four decades. The membranes now must be considered as an integral part of the cell machinery. Far from being passive structures restricting exchange, they are the sites of important cellular functions, what has been termed as active transport.

Before going any further, several mechanisms by which substances are thought to cross cell membranes should be defined because their clear distinction is important. These mechanisms are based on kinetic and thermodynamic considerations described below.

Passive diffusion or non-mediated transport process. The solute or a metabolite crosses the membrane as a result of random molecular motion, and does not interact specifically with any molecular species in the membrane. The rate of a passive diffusion process is at all times directly dependent on the concentration of solute (Fig. 1).

Facilitated diffusion or mediated uptake process. The solute combines reversibly with a specific carrier molecule in the membrane, and the carrier-solute complex oscillates between the inner and outer surface of the membrane releasing and binding solute on either side. Here the transport system can become saturated with the substance transported, just as enzymes can become saturated with their substrates (Fig. 1).

All mediated transport processes across biological membranes share three common characteristic properties of saturability, substrate specificity and specific inhibition. They are further divided into two types, active and passive, depending on other criteria.

Passive transport is different from the passive diffusion process as it is carrier mediated. It occurs only up or down the gradient and is never against a concentration gradient.

In active transport the solute accumulation is energy dependent, and against a concentration gradient. In contrast to passive transport, active transport is uni-directional, i.e., the substrate will move across the membrane in only one direction. From the characteristic properties described above, generalized models of transport systems have been proposed. Such models postulate that a specific protein containing a binding site complementary to the substrate transported serves as a carrier of the substrate. By diffusing across the membrane, by rotating, or by a conformational change, it carries the substrate molecule across the membrane so that the binding site now faces the other

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compartment into which a bound substrate is discharged. In passive mediated transport systems, the process is completely reversible, and the net movement of solute molecules may be in either direction, depending upon the relative concentration of the substrate in two compartments (Fig. 2). In models of active transport systems, the carrier molecule is 'energized' in some manner to achieve uni-directional transport against a gradient, for example, by an energy-dependent alteration of the substrate binding affinity of the transport system on one side of the membrane (Fig. 3).

Group translocation

Another transport mechanism which is metabolically dependent is group translocation. In this process a covalent change is exerted upon the transported molecule such that the reaction itself results in the passage of the molecule through the diffusion barrier. This is not the 'classic' active transport mechanism since the transported solute is modified chemically (Fig. 4).

Until recent years little biochemical information was available about the molecular basis of active transport. Most investigations were limited to the rates and the specificity of active transport processes in intact tissues and cells. However, as a result of new experimental techniques, a number of membrane proteins participating in active transport have been isolated. Today the molecular basis of membrane transport is a large and rapidly growing area of biochemical research.

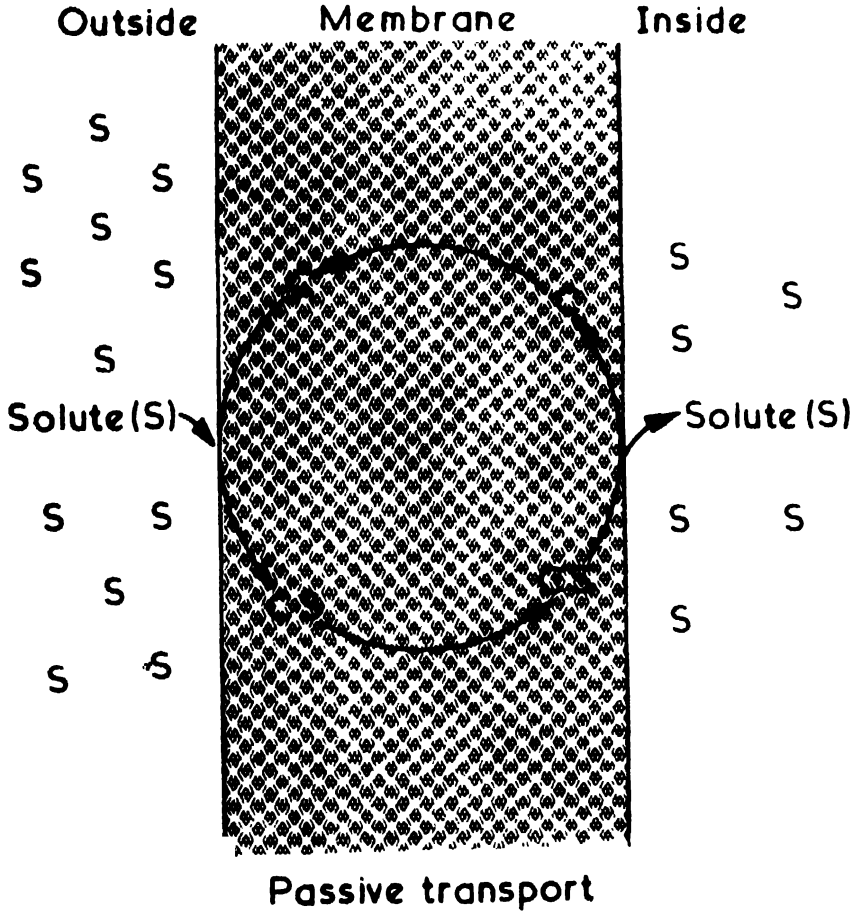


Fig. 2. Passive transport: solute (S) combines with a specific transport carrier (C) to form a CS complex, which carries S across the membrane

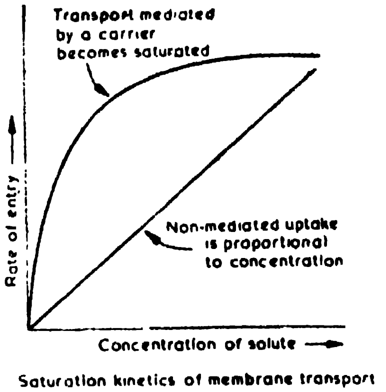


Fig. 1. Mediated and unmediated transport

Bacterial membrane vesicles as a model for transport studies

Bacterial transport systems are very powerful, in consonance with the high rate of metabolism of the organism compared with eukaryotic cells. Bacteria also offer the advantage that genetic analysis of its transport system can easily be carried out. Moreover, simple methods have been devised to obtain membrane vesicles from bacteria. In fact, most of the work on active transport in bacterial system has been done with membrane vesicles rather than the whole cells. Although whole cells may also be used for transport studies, it is often difficult to separate transport from subsequent events in intracellular intermediary metabolism. One of the important advantages offered by the membrane vesicles is the opportunity of investigating their transport functions apart from other cellular activities. At the same time, the isolated transport systems of membrane vesicles are retained in a functional form and their relationship to other membrane components can also be studied. Work with isolated bacterial membrane vesicles has led to the elucidation of the transport mechanisms of sugars, amino acids and also of nucleosides and nucleotides in several bacterial species.

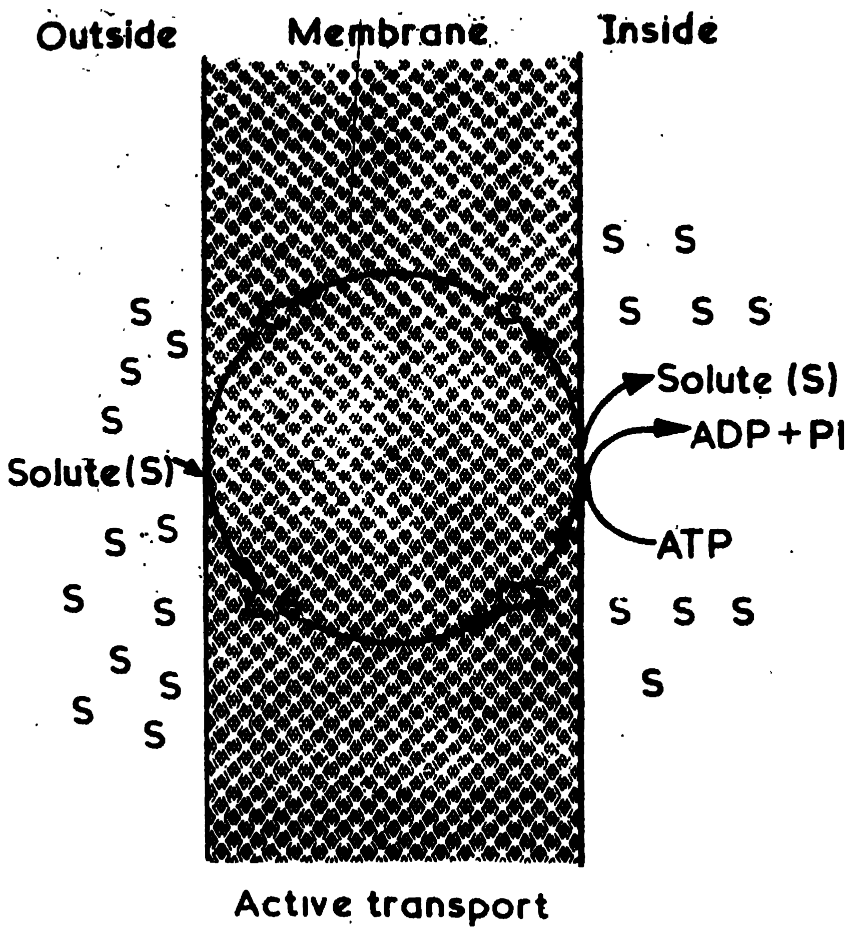


Fig. 3. In this model the energy of ATP is applied to unload the solute (S) from the carrier (C) on the inside surface

Sugar transport systems

Two general types of sugar transport systems occur in bacteria. One promotes group translocation of the sugar across the membrane so that it enters the cytoplasm in a different chemical form, while the other promotes active transport linked to respiration. Group translocation is mainly found in facultative and photosynthetic bacteria but appears to be absent in strict aerobes. In 1964, a bacterial phosphotransferase system (PTS) was reported which catalyzes the transfer of phosphate from P-enolpyruvate to various carbohydrates according to the following reaction:

$$\text{(a) Phosphoenolpyruvate} + \text{HPr} \quad \text{Enz.I}Mg^{2+} \quad \text{Pyruvate} + \text{P—HP} \rightleftharpoons$$

$$\text{(b) P—HPr} + \text{Sugar} \quad \text{Enz.II}Mg^{2+} \quad \text{Sugar—P} + \text{H—Pr} \rightleftharpoons$$

This reaction is unusual in two respects. Firstly, it involves P-enolpyruvate as the immediate phosphate donor, whereas most biological phosphorylation requires ATP or some other nucleoside triphosphate as phosphate donor. Secondly, the HPr protein becomes phosphorylated on nitrogen atom 1 of the imidazole ring of one of its two histidine residues. HPr has been purified to homogenity. Recently, phosphotransferase system has also been reconstituted from the purified components. A diagramatic representation of glucose transport via this mechanism is shown in Fig. 5.

Sugar and amino acid transport coupled to electron transport in bacteria

In addition to PTS system for group translocation of sugars, a system of respiration coupled active transport of sugars and amino acids is known in certain bacterial cells like *E. coli* where phosphorylation of sugar does not appear to be involved. Kaback, an American biochemist, and his group have extensively studied this aspect of transport using membrane vesicles. These vesicles promote active transport of several sugars and amino acids in the presence of some oxidizable substrates like lactate, succinate, etc., which provide the necessary energy for their accumulation against a concentration gradient. It has been shown with the use of various respiratory inhibitors that even oxidation alone (in the absence of its coupling to the phosphorylation of ADP and Pi) is sufficient to drive the uptake. There are two hypotheses about the mechanism by which the energy of electron transport is utilized to drive the active transport of sugars and amino acid in the vesicles against a rather steep concentration gradient. According to one hypothesis supported by Kaback, one (or more) of the electron carriers in the respiratory chain (in the bacterial membrane) functions not only to transfer electrons but also to transport sugar or amino acids across the membrane. He postulates that one of the specific electron carriers in this chain occurs in disulfide (oxidized) and sulphydryl (reduced) forms. These two forms are also capable of binding the substrate or metabolite being transported. The disulfide form of the carrier is regarded as 'high affinity form' capable of binding the substrate or metabolite only on the outside of the membrane (Fig. 6A). The disulphydryl (reduced) form is believed to bind the substrate on the inside surface of the membrane with much lower affinity. Thus, the oxidized form of the carrier traps the substrate molecule from the external medium with high affinity, and the carrier molecule, which is reduced by electrons coming from electron donors, undergoes a conformational change resulting in a large decrease in affinity and consequent unloading of the transported substrate at the inside surface of the vesicles (Fig. 6B). A specific role of sulphydryl groups in sugar and amino acid transport is suggested by the fact that reagents capable of blocking —SH groups also block active transport. However, it has been observed that the rate of oxidation of substrates is from ten to several hundred times greater than the rate of sugar or amino acid transport on a molecular basis. Also, the proposed model is unable to explain active transport of various solutes under anaerobic conditions. The strongest argument against a direct coupling of electron flow with transport comes from the observation that uncouplers of oxidative phosphorylation, like DNA, azide, etc., interfere with the transport without affecting cellular respiration. The obvious interpretation is that respiration alone cannot be sufficient for energy coupling. Isolation of a bacterial mutant deficient in transport capacity but normal in respiration corroborates this interpretation.

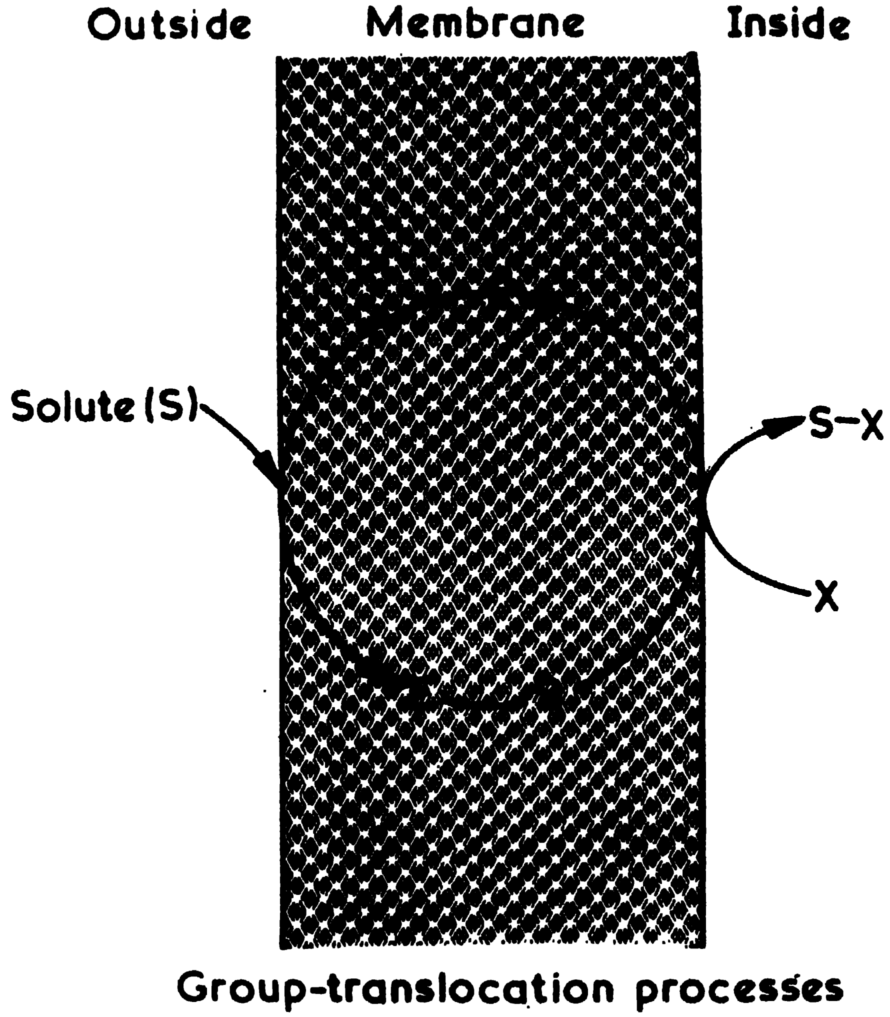


Fig. 4. The outside solute (S) is acted upon by a membrane-bound enzyme (E) together with a second substrate (X) to yield the product (S-X) which is discharged at the inside surface of the membrane

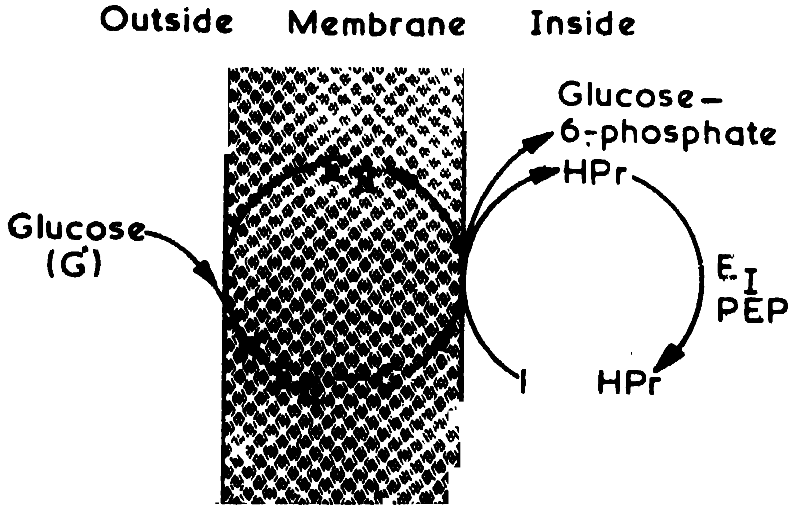


Fig. 5. Energy coupled group translocation of glucose across the bacterial

An alternative hypothesis for the mechanism of energy coupling between electron transport and inward transport of sugars and amino acids has been proposed by Mitchell and Harold. It says bacterial sugar transport is brought about by chemiosmotic coupling, as originally developed for oxidative phosphorylation. It proposes that electron transport generates an electrochemical gradient of H^+ ions across the membrane, composed of an outside H^+ gradient and an inside negative membrane potential. This gradient, called proton motive gradient, has been postulated as the immediate driving force for ATP formation

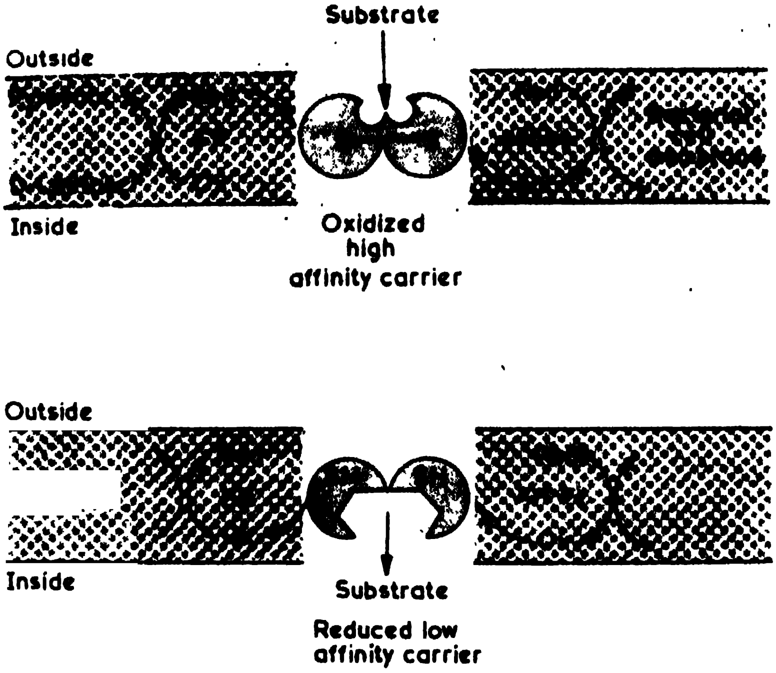
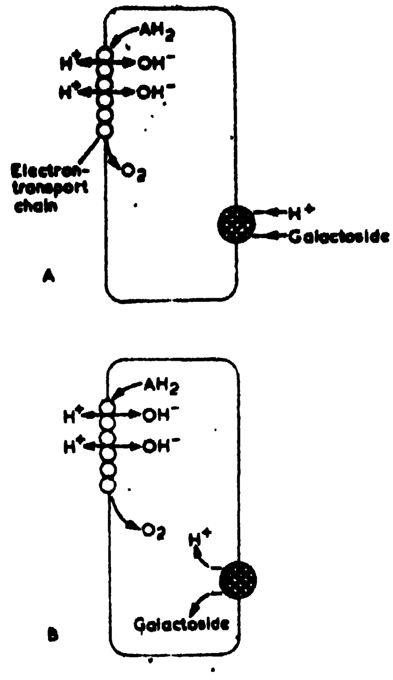


Fig. 6. Coupling of the active transport of an external substrate to electron transfer. The respiratory chain of the bacteria is in the cell membrane



Transport of galactoside coupled to proton movement

Fig. 7. Active transport of galactosides into bacterial cells by obligatory cotransport of H^+ and the galactoside

and for other energy-dependent functions of mitochondria and chloroplast including ion transport.

Several evidences support the chemiosmotic hypothesis as the principal means of energy coupling in membrane vesicles. Electron transport in such vesicles has been shown to generate a membrane potential and to cause extrusion of protons. It has also been shown that the membrane carrier for galactosides also carry H^+ across the membrane into the cell, apparently in a 1 : 1 relationship (Fig. 7). When vesicles not capable of electron transport are placed in a medium containing a labelled galactoside and then acidified to pH 6.0 to create an inward gradient of H^+, the galactoside is transported into the vesicle together with H^+.

Although the idea of the proton-motive force as a unifying mode of energy coupling for transport appears attractive, it seems premature at present to postulate its general importance. The diversity of transport systems in their genetic and mechanistic appearance may indicate that the chemiosmotic model may be one, but by no means the only, form of energy coupling for active transport in bacteria.

Further reading

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SCIENCE SPECTRUM

Looking for sun-like stars

WHY should one look for sun-like stars? Of course, to understand how our solar system was formed and, secondly, to know the chances of finding earth-like planets elsewhere—for communication with intelligent life if there is any. Both these motives make the search for sun-like stars stimulating, notwithstanding the handicap that telescopes of the required power are not available to make a thorough study of the stars around. What is therefore done is to make a sample survey and try to deduce from it plausible conclusions.

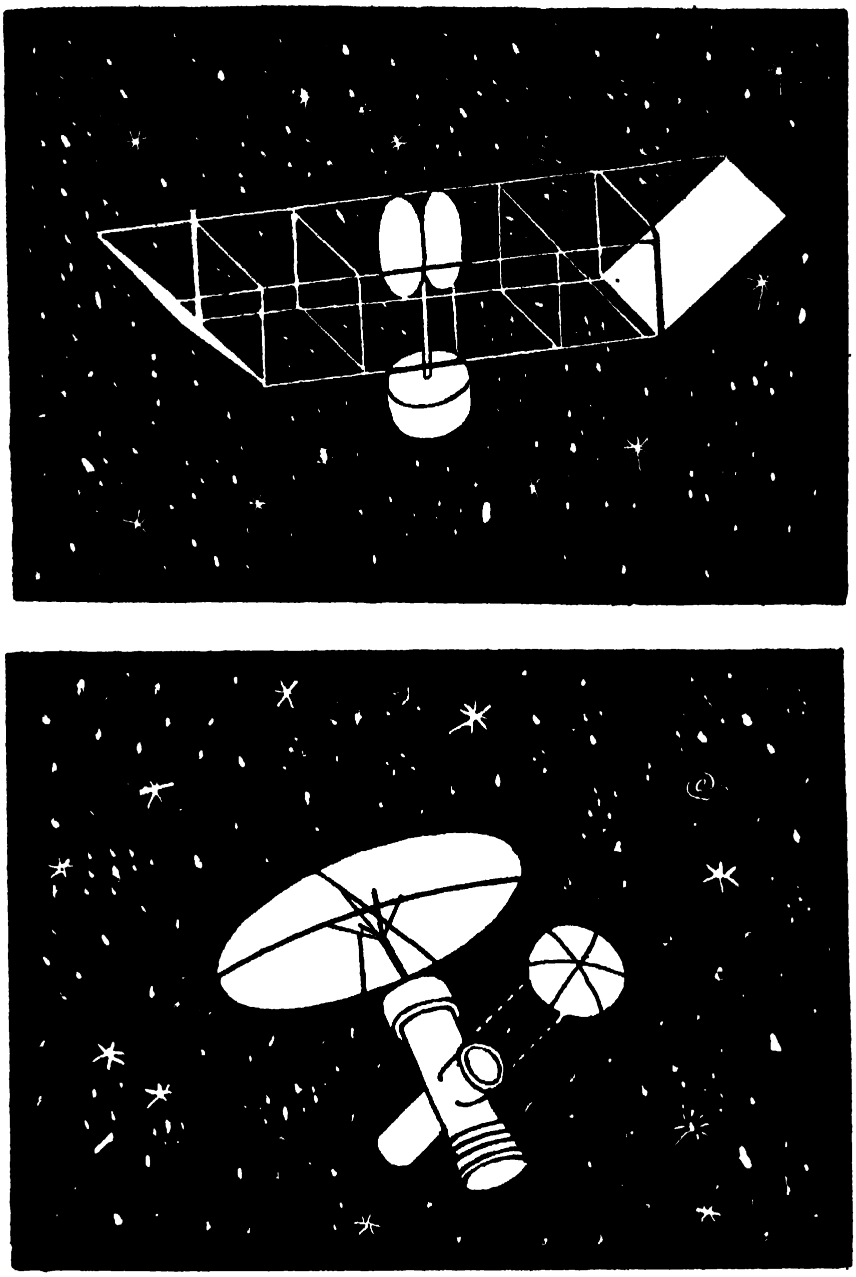
Before the survey is discussed, what is meant by a sun-like star should be clear. It is a star similar to sun, having the same temperature, diameter, and should have evolved just as the sun has. However, all stars are not alone as the sun is supposed to be. They are present in groups of twos, threes, and so on. Generally, they rotate about each other. The one among them which is the biggest, or about which its companions revolve, is called primary, while the rest are called secondary. The time a secondary takes to go round the primary is called the period of revolution, which can be measured by spectroscopic or other means. The periods range from a few hours to thousands of centuries.

In 1930s and 1960s surveys were conducted at some observatories to know what percentage of sun-like star population is present as singles, in twos, threes, or multiples. Results however proved inconclusive as the percentages widely differed in the two surveys. Recently, Saul Levy and Helme A. Abt (*Scientific American*, April 77) have conducted a different kind of survey at Kitt Peak National Observatory, Arizona. They studied 123 sun-like stars which are visible to the naked eye in the northern hemisphere. It has been found that two separate categories of sun-like stars are present, depending on their period of revolution. One category of stars has a period less than 100 years and the other more than that.

In the first category of stars 67 per cent were found to be double or multiple, and the rest singles. Why there is majority of double or multiple stars is easy to explain. It is well-known that stars are generally formed when dense clouds, called nebulae, coalesce, just as on a smaller scale rain droplets form out of clouds. Often, clusters of stars get formed. As these stars are spinning rapidly, and thereby are unstable, each of them eventually splits into two. The two thus formed are stars of the same mass; they spin very slowly and are stable. Now it is easy to conclude that the dominant tendency is to form a double or multiple star system with equal masses rather than that with unequal masses.

In the case of stars with unequal masses which form a minor portion of the population, those stars whose secondaries are comparatively larger are seen as doubles. But what about those secondaries whose masses are a fraction of the solar mass ? They appear like single stars and in the survey they comprise 33 per cent of the population of sun-like stars. Actually, they are having non-luminous companions such as black dwarfs (not to be confused with black holes) or planets. Theoretically, 13 per cent of these so-called single stars should have black dwarfs as companions and the remaining 20 per cent, planets.

These conclusions are drawn from the research work of Shiv S. Kumar of Virginia University. According to him, a star having mass one sixteenth that of the sun cannot generate nuclear reactions to produce illumination, and be visible to eye as a star. All stars having a mass less than this fraction become black dwarfs. As gravitational contraction goes on, they emit electromagnetic waves and thus continue to glow in such a way for a billion years or so. Subsequently, the lesser the mass, the less they glow. When the mass of such a secondary star is one-hundredth of sun's, it hardly glows. It is analysed that, instead of black



Designs for telescopes to be installed in space

dwarf, the sun-like star has then a coterie of planets as companions.

In the second category of stars with periods greater than 100 years, it was found that 72 per cent of them have distant stellar companions. These stars have been visualised as having been born separately as two stars in the same manner as above. Thereafter, this pair binds itself gravitationally with another pair. They have large periods of revolution because they are far apart. For the rest of the stars, the same conclusions hold good as in the first category of stars.

The question that comes uppermost in mind now is: Is sun a lonely wanderer ? Or are such cases rare ? Even in case of sun there is yet no final answer. There is a possibility that it may be having a faint star, almost at the edge of solar system, as a companion. Moreover, no star takes birth in the universe alone; they are always born as twins. The lonely ones are those which had escaped from cluster of stars during its (cluster's) disintegration.

Project Orion

To date, neither black dwarfs nor planets about a sun-like star have been detected. There is only an inconclusive evidence that the Barnard's star is attended by planets. It is based on the fact that a star wobbles, however minutely, if it has companions. To search for planets, and especially for earth-like planets, NASA has recently launched the Project Orion. Its purpose is to install powerful telescopes in outer space, away from the atmospheric disturbances and the restrictions of earth.

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Can we see atoms ?

ATOMS which constitute matter are so small in size that it has not been possible until recently to see them with the help of any powerful instrument. Its existence has been established with the help of various instruments like cloud chamber, spark or bubble chamber or stacks of nuclear emulsion etc. In recent years, advances in electronics and electron optics have created super-powerful instruments like ion-field emission microscope which enable us to see atoms clearly.

From the days of Leeuwenhoek microscope in the seventeenth century, man has been trying to increase the magnifying power of optical

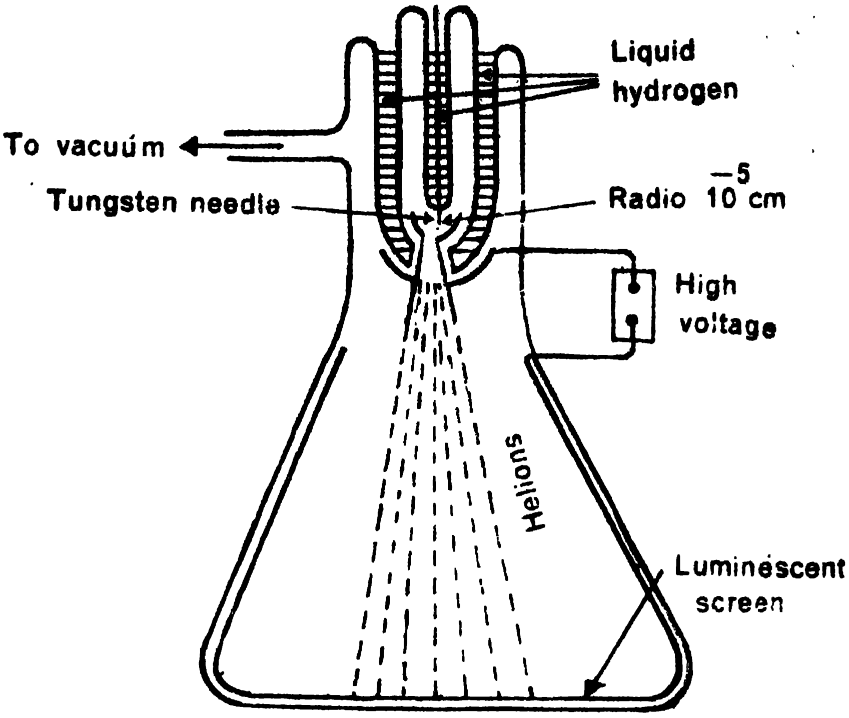

Fig. 1

microscopes which have enabled us to see many minute particles like bacteria, protozoa, fungi, etc. Optical microscopes have undergone tremendous advancement since then and their magnification has increased 1500-2000 times. Ultra-microscopes which came later have helped us to see even those smaller particles which optical microscopes failed to show up.

Optical microscopes, however powerful they may be, failed to show atoms because light waves do not get reflected from an object whose diameter is smaller than the wavelength of the incident light. As diameter of atoms is of the order of 2-5 Angstrom (1 Angstrom = 10^{-8} cm) and light waves have wavelengths of 4000-8000 Angstrom, it is not expected that atoms will reflect the light rays and form images. Light rays will simply pass around them without forming their image. That is why atoms have remained invisible even under powerful optical microscopes. Optical microscopes utilizing ultraviolet rays can show many minute particles invisible under ordinary light, but such a microscope is also useless in showing more minute atoms.

To see atoms in an optical microscope, one may argue that X-rays or γ-rays having smaller wavelengths than the diameter of the atoms may be used. But then, these rays are unable to create any image of the atom due to shortness of their wavelengths.

Limitations of optical microscopes were removed when electron microscope came into use. Its magnification was exceedingly high, of the order of 400,000 to 500,000 times that of an optical microscope. In place of light rays, it utilises electron beams and thus can reveal the shape of virus and many individual giant molecules of plastics and rubber. However, even this microscope is unable to show an individual atom.

It was then felt that instead of electrons, whose mass is negligibly small, protons, deuterons or alpha particles, whose masses are several thousand times more than that of electrons, may be used. When they are accelerated to high velocities they behave like waves having wavelengths much smaller than those of electron waves. Such an instrument can take photographs of still smaller particles which an electron microscope is unable to show. Ion field emission microscope is such an instrument which was able for the first time to show the shape of atoms and metal surface by taking their photographs. This microscope was perfected by Dr. Ervin W. Muller of the University of Pennsylvania, U. S. A. of Geiger-Muller counter fame in 1956. It gives a magnification of the order of five million times or more, i.e., 30 to 49 times more powerful than an electron microscope. The arrangement of atoms in a tungsten needle was clearly shown in the photograph taken by this instrument.

Field emission is a physical effect which consists of the emission of electrically charged particles from a conductor under the influence of a strong electrical field. This phenomenon was first observed in 1897, but the credit of utilizing the field emission technique to set up a superpowerful microscope goes to Dr. Müller.

The ion field emission microscope consists of a double or triple walled flask specially built for the purpose. The space between the glass walls is filled with liquid hydrogen or nitrogen. The bottom of the flask is coated with a luminescent compound which forms the screen of the microscope just like the picture tube of a television set. A tungsten electrode ending in a very fine needle (radius=10^{-5} cm) is kept at the centre of the flask. The needle is cooled to liquid hydrogen or nitrogen temperature,

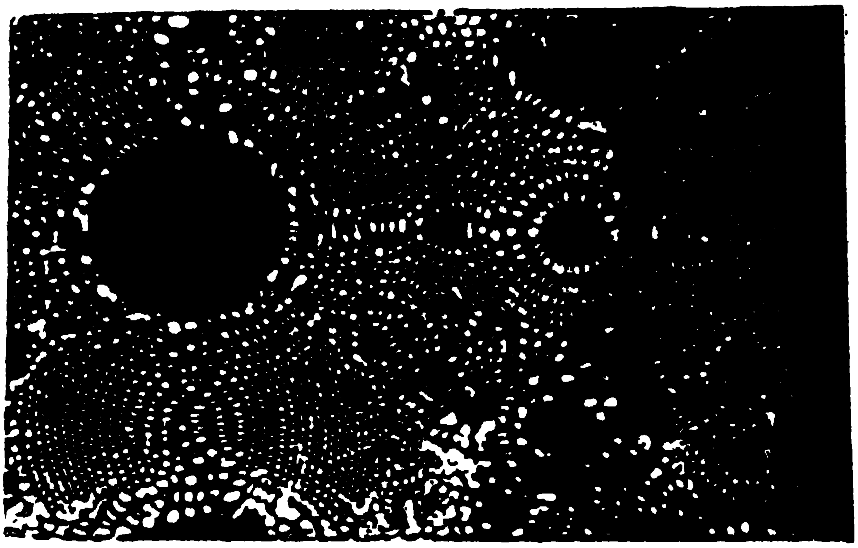

Fig. 2. **The bright spots are tungsten atoms on tungsten needle seen in the ion field emission microscope**

by keeping it partially submerged in the liquid. The tip of the needle which is outside the liquid faces the screen as shown in Fig. 1. A high electric potential difference of the order of 30,000 volts is maintained between the needle and the screen. Owing to the small radius of the tungsten needle tip, the actual potential difference is magnified to the order of 500 million volts per square centimeter. The flask is evacuated and a small amount of helium gas is introduced at a pressure of one micron only.

At that low pressure, when the helium atoms come in contact with the tungsten needle, the electrons of the helium atoms are knocked out due to the high positive charge of the needle. This results in the formation of helium ions known as alpha particles. The helium ions are attracted strongly by the negatively charged screen and thus gain a tremendous velocity. They hit the screen and make it brightly luminescent. Since the tungsten needle has a stepped crystalline structure, the image is exactly like the stepped structure of the needle's surface. Here the magnification is of the order of 2,000,000 times. Each light point obtained on the screen corresponds to the location of an atom in the crystal lattice of the tungsten needle.

The need for cooling the tip of the needle by liquid hydrogen or nitrogen is to avoid distortion of the image by the wandering helium ions. These ions are formed not by the needle but due to their high kinetic energy. When they hit the screen, they cause unwanted luminescence which distorts the image of the atom. On cooling to the temperature of liquid hydrogen (−252 °C), the kinetic energy of such helium atoms is reduced almost to zero. As a result, their unwanted wandering is stopped and a better picture of the atom is obtained. A clear picture of the tungsten atoms could be taken as shown in Fig. 2.

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Emulsion polymerisati

THE production of high polymeric materials is an increasingly important technological problem. All fibres, natural or synthetic, are derived from high polymer compounds. Natural fibres are obtained from cotton, jute, flax, hemp, ramie, etc., as well as from silk. Some synthetic fibres are made from natural high polymers such as cellulose and protein. Such synthetic fibres are therefore called semisynthetics. Other synthetic fibres are obtained by synthesising high polymers or high copolymers from different monomers prepared artificially.

The earliest polymerisation techniques involved the use of simple batch processes. The monomer, or the mixture of monomers, was polymerised in bulk to the desired degree of polymerisation by using some appropriate catalysts. However, unless the degree of polymerisation is sharply limited, considerable processing is required. This is because polymerisation reaction is strongly exothermic, and, as high reaction temperatures lead to undesirable effects, efficient cooling is essential. This, however, is hindered by high viscosity which renders efficient stirring and hence efficient heat transfer extremely difficult.

These difficulties are obviated by the use of emulsion polymerisation, a recent technique used in manufacturing polymers. Here the monomer is emulsified in a medium, generally water, with the acid of emulsifying agent such as soaps and surfactants. The monomer is thus present almost entirely as emulsion droplets dispersed in a continuous phase (water). It was at one time

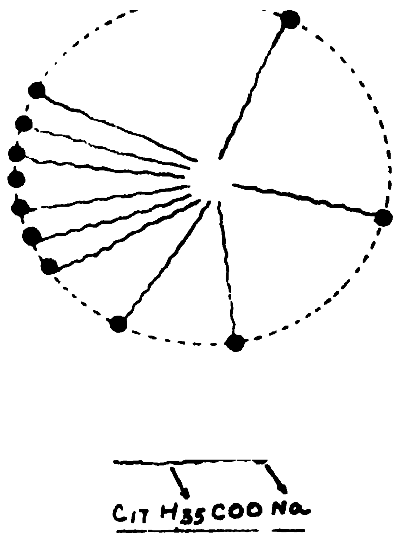

Fig. 1. A soap micelle

supposed that polymerisation took place within the emulsion droplets, and for this reason the term 'emulsion polymerisation' was used for this type of reaction. Although we know now that the emulsion droplets play only a minor role in polymerisation, the name has been retained.

Some of the advantages of emulsion polymerisation are : (i) the heat transfer presents no difficulty as the viscosity of emulsion remains low during polymerisation; (ii) polymers of high molecular weight can be obtained at a very high rate of polymerisation; (iii) sticky, rubbery polymers which in some cases (such as formulations of coatings) are suitable for many direct applications, can be produced; and (iv) due to the solubility of catalysts in water, their effectiveness is enhanced, and so polymerisation can be carried out at a lower temperature.

A simple recipe for emulsion polymerisation comprises four ingredients: the monomer (e.g., styrene), the continuous phase (water), the emulsifing agent (e.g., soaps or surfactants) and the initiator (e.g., potassium persulphate).

While the polymerisation process just described is fairly simple, elucidation of the mechanism requires a detailed study of the properties of soap solutions, production of free radials from the activator and chemical and kinetic aspects of polymerisation itself. However, one can understand the process of polymerisation in a simplified way.

Ingredient	*Parts by weight*
Styrene	100
Water	180
Surfactant	5
Potassium persulphate	0.15

Soaps and surfactants in aqueous solutions form micelles containing about 50-100 molecules. These micelles may have the shape of short cylinders (Fig. 1). The reason for the formation of micelles is the attractive (vander Walls) forces between the hydrocarbon proteins of the surfactant molecules. These forces are, of course, the strongest when the molecules are aligned parallel to each other as shown in the figure. Each micelle consists of two layers, or palisades, of surfactant molecules set "back-to-back" with the hydrocarbon portion close together and the carboxylate portion (as in the case of metallic soaps) in the aqueous phase.

On addition of liquid monomer (e.g., styrene) to the micellar surfactant solution, a part of it is solubilized in water (with the monomer in the interior of the surfactant micelles) and the other is emulsified in the form of droplets which are stabilized by surfactants.

On addition of initiator (e.g., potassium persulphate) to the mixture, polymerisation of the solubilized monomer begins. The mechanism of action of initiator may be ionic, radical or both. The molecular weight of the polymer formed at the beginning of polymerisation is far greater than that corresponding to the number of monomer molecules solubilized in one micelle. The polymer radical chain formed in one micelle grows by addition of more monomer molecules, which are supplied by diffusion of monomer molecules from other micelles and possibly from emulsion droplets. Such a polymer chain radical becomes too big to be contained in a surfactant micelle. It is terminated by combining with another growing polymer chain radical with formation of a polymer particle.

When some polymer is formed, it functions like surfactant micelles in solubilizing monomers, e.g., polystyrene particles can solubilize appreciable amount of styrene. Again a similar process starts. The ions of initiator produced in the aqueous solution collide with polymer particle and initiate further polymerisation. Sometimes some modifier is also added to increase the speed of polymerisation.

Many polymers are made on large scale by the emulsion technique. They include polystyrene, butadiene-styrene copolymer, butadiene-acrylonitrile rubbers, neoprene, polyvinyl chloride, copolymer of vinyl chloride with vinyl acetate, vinylidene chloride, etc.

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Why are cyanides so poisonous ?

CYANIDES, even in a very small dosage, are considered highly toxic because of their rapid action; they cause instantaneous death. It will be interesting to know how and why they cause quick death.

The red pigment of blood, haemoglobin, is a conjugated protein of high molecular weight. The haemoglobin molecule contains four atoms of iron and is probably an aggregate of four single molecules called heme or haem (Fig. 1). Each of the heme group is attached to a polypeptide chain. The iron content of the haemoglobin is about 0.34% and the iron atom is in ferrous state.

Haemoglobin

The most characteristic and physiologically important property of haemoglobin is its ability to take up a relatively large volume of oxygen (1.34 ml/g of haemoglobin at N. T. P.) at a high oxygen pressure, and to give it up when the oxygen partial pressure is low. The compound formed by the combination of oxygen and haemoglobin is called oxyhaemoglobin. The ability of haemoglobin to combine reversibly with molecular oxygen instead of reacting chemically fulfils a vital transport function. On the other hand, haemoglobin holds oxygen so loosely that it can be easily displaced by other gases which form more stable compounds. In carbon monoxide poisoning, for example, carboxyhaemoglobin is formed by the displacement of oxygen from oxyhaemoglobin. This causes hypoxic symptoms and finally death. Nitric oxide forms an even more stable compound, nitric-oxide-haemoglobin. The toxic action of hydrocyanic acid is, however, not because of the formation of cyanohaemoglobin. It arises due to the interaction of hydrocyanic acid or a cyanide with methaemoglobin, forming a compound called cyanomethaemoglobin.

Methaemoglobin is a brown pigment that is formed when blood or haemoglobin solution is exposed to air or light for a long time. The same can also be obtained by treating haemoglobin with mild oxidizing agents such as potassium ferricyanide, ozone, nitrites or chlorates. The compound is a stable oxidation product of haemoglobin and is quite distinct from the latter. The differences are: (a) it does not loose oxygen in vacuum; (b) reacts with cyanides, sulphides and other anions; (c) contains only half as much added oxygen as oxyhaemoglobin, (the iron carries one oxygen atom instead of two); and (d) iron is present in the higher oxidation state. (This is very similar to the case of ferrocyanides and ferricyanides wherein they differ only in the state of oxidation or the valency of the central iron atom.) It is now known that small amounts (2%) of methaemoglobin exist normally in human blood in equilibrium with haemoglobin.

Neither oxygen nor carbon monoxide is able to combine reversibly with ferric heme groups of methaemoglobin because the methaemoglobin molecule possesses a net positive charge. But negatively charged ions like cyanide (CN-), hydrosulphide (HS-), etc., can combine easily. In cyanomethaemoglobin, each heme group takes up one cyanide ion, that is, cyanomethaemoglobin contains one cyanide ion for each of the four heme groups of the methaemoglobin.

Although it may appear from the above statement that all negatively charged ions should be as effective poisons as cyanide, actually it is not so. The reason is that all the reaction products are not as stable as cyanide compounds. They undergo a slow auto-reduction to haemoglobin and other products. Table 1 summarizes information about relative affinities of various anions for ferric heme groups expressed as the dissociation constants of the anion-methaemoglobin complex. A small dissociation constant means that a particular ligand has a very high affinity for ferric heme groups.

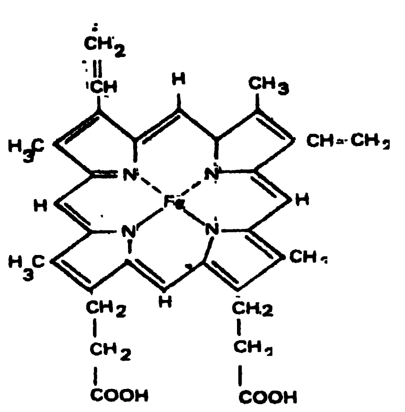

Fig.1. Structure of heme

Cytochrome oxidase

Another factor responsible for the toxic effect of cyanide ion is the inhibition of cytochrome oxidase, the terminal enzyme in the respiratory electron chain which directly utilises the molecular oxygen transported to it by haemoglobin. The cytochromes are a group of pigments present in a large number of organisms and tissues which take part in the oxidation-reduction reactions. They consist of a characteristic protein and a heme compound. There are at least three cytochromes designated as *a*, *b*, and *c*. The best known of them is cytochrome *c*. It contains 0.43% iron and is believed to have a molecular weight of 13,000. Cytochrome *c* functions as an electron carrier in cellular oxidation-reduction reactions by virtue of its iron atom which alternatively changes its valence from 2 to 3. It is possible that cyanide ion combines with the ferric heme form of cytochrome oxidase in a manner analogous to its combination with methaemoglobin. Thus cyanide blocks the oxidative metabolism at the cellular level instead of impairing oxygen transport as in the case of carbon monoxide poisoning. The end result is much the same in either case. Death results from the failure of the respiratory system.

Table 2. Apparent dissociation constant values in moles/litre

Anion	Nitrte generated methaemoglobin	Ferricyanide generated methaemoglobin
CN^-	2×10^{-8}	2×10^{-8}
HS^-	6×10^{-8}	3×10^{-5}
N_3^-	2×10^{-5}	2×10^{-5}
NO_2^-	3×10^{-3}	—

Hydrocyanic acid can enter the body in the usual way by inhalation, skin absorption or oral absorption. Absorption in the stomach is highly fatal; one mg of cyanide per kg of body weight is sufficient to cause death. The symptoms of cyanide poisoning include dizziness, headache, rapid pulse, nausea and bloodshot eyes. More prolonged exposure can cause immediate unconsciousness and rapid death.

Antidote

The best antidote in case of cyanide poisoning is sodium nitrite. When a small dose of sodium nitrite is injected intravenously, a portion of oxyhaemoglobin in the cyanide victim's body is converted into methaemoglobin. This methaemoglobin fraction is then able to trap free cyanide in the blood stream as cyanomethaemoglobin, thereby preventing it from reaching the cytochrome oxidase. There is evidence to suggest that methaemoglobin is able to compete effectively with cyanide that is already bound to cytochrome oxidase, thus reversing the inhibitory effect. At this point, however, the red cells of the patient contain cyanomethaemoglobin, a pigment not only incapable of oxygen transport but which also slowly releases free cyanide. For complete detoxication of cyanide, the nitrite injection is followed by sodium thiosulphate. The latter is utilized by an enzyme rhodanase, present in body to transform cyanide to relatively harmless thiocyanate. Thiosulphate injections serve to accelerate the rate of this transformation; thiocyanate is excreted in the urine.

After the release of cyanide, a slightly elevated concentration of methaemoglobin may remain in the blood. This pigment is gradually reduced to normal haemoglobin by an enzyme, methaemoglobin reductase, or diaphorase. Since small amounts of methaemoglobin exist normally in human blood in equilibrium with haemoglobin, sodium nitrite in blood temporarily displaces the equilibrium in favour of methaemoglobin.

Methylene blue has also been found to have significant beneficial effect in cyanide poisoning, but the effects are less dramatic than with nitrite and thiosulphate. The mechanism of action of methylene blue is not clear.

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Role of algae in sewage treatment

SEWAGE is used water. It contains organic and inorganic substances which exist either in suspension, in colloidal state, or in solution. In addition, sewage also contains a large number of faecal bacteria, some of which may be pathogenic. Table 1 shows the typical composition of domestic sewage.

Sewage with its several impurities has to be somehow disposed of. The common method of disposal is to discharge it into rivers, lakes, or other water bodies. The organic impurities of sewage are highly putrescible, and may rapidly deplete dissolved oxygen in the water leading to fish mortality, evolution of bad odours and other serious nuisance. The pathogenic organisms in sewage may also cause spread of bowel diseases. To avoid such and other dangers to health, it is necessary to treat sewage prior to its disposal.

One of the important means to determine the quality of sewage is by the measurement of its biochemical oxygen demand (BOD). This is defined as the weight of dissolved oxygen (usually in milligram) required by a definite volume of liquid (usually 1 litre) during five days of incubation at 20°C. The aim of purifying sewage is to reduce the BOD, so that if effluent water runs into a pond or river, the indigenous flora and fauna will not die of lack of oxygen. The purification system of sewage is therefore designed to render the organic matter in sewage harmless and inoffensive.

The purification of organic matter can be accomplished only by biological processes requiring abundant supplies of oxygen. A recent development in the biological treatment of sewage is the utilisation of the natural phenomenon of algal photosynthesis for supplying required oxygen.

In the presence of sunlight, during

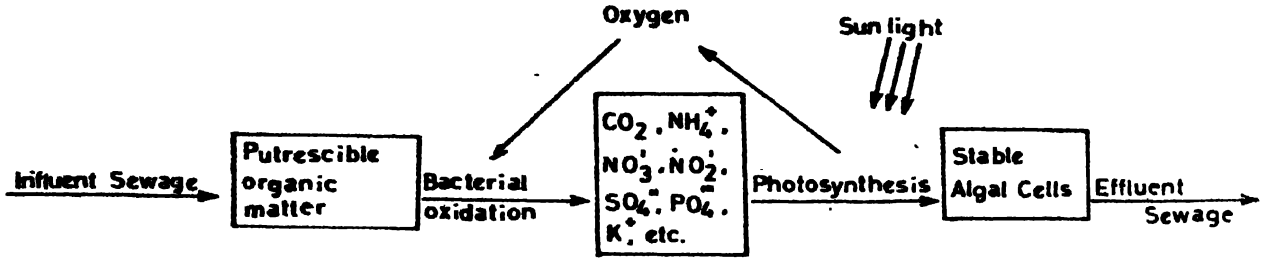

Fig. 1. Symbiosis between algae and bacteria in sewage treatment

Table 1. Typical composition of domestic sewage

S. No.	Constituents	% Organic carbon
1.	Fatty acids	22.8
2.	Carbohydrates	17.7
3.	Protein	10.0
4.	Fatty acid esters	9.1
5.	Soluble acids	6.8
6.	Anionic surface active agents	4.5
7.	Amino acids	1.6
8.	Creatinine	1.1
9.	Amino sugars	0.6
10.	Amides	0.5

photosynthesis, algae utilise carbon dioxide and water and liberate oxygen. The reaction is :

$$6\,CO_2 + 6\,H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6O_2$$

Carbohydrate Oxygen

The end products of this reaction are carbohydrates required for algal growth and free oxygen. This oxygen is liberated outside the cell. The photosynthetic efficiency of algae is very high and large quantities of free oxygen are produced during photosynthesis. Although a part of this oxygen is utilised by algae in their respiratory processes, the total amount of oxygen produced under satisfactory conditions of light by algae during photosynthesis far exceeds their respiratory oxygen uptake. Algal photosynthesis can therefore produce surplus oxygen, and by allowing algae to grow in sewage, the surplus oxygen can be made available for the biological oxidation of sewage without any expense.

As sewage contains almost all the nutrient elements required for plant growth such as carbon (C), nitrogen (N), phosphorus (P), sulphur (S), and potassium (K) etc., algae can very well grow in the sewage. Being present in sewage as complex organic compounds, these nutrient elements cannot however be directly assimilated by algae, and have to be oxidised first into simple, assimilable inorganic forms like CO_2, NH_3, SO_4^{2-} NO_3^- PO_4^{3-}, etc. Oxidation in nature is achieved by a complex symbiosis of algae and bacteria. The algae produce the oxygen required for bacterial respiration, and the bacteria, utilising this oxygen, oxidise the organic compounds in the sewage into inorganic forms suitable for algal utilization.

A diagrammatic representation of the symbiotic relationship which takes place between algae and bacteria in sewage is presented in Fig. 1.

The algae–bacteria symbiosis does not affect the final mineralization of the organic matter in sewage, but only brings about a change in its nature. Though oxidised into inorganic compounds at an intermediate stage, the impurities are finally reconverted into organic matter in the form of algal cells. The treatment therefore does not reduce organic content of the sewage, but it makes it stable and inoffensive.

The algal organisms commonly noticed in sewage ponds have been reported to be green algae, *Chlamydomonas*, *Scendesmus*, *Euglena and Chlorella*. These planktons are able to tolerate sewage pollution to various degrees. The chemical quality of sewage and temperature are important factors in deciding the growth of each species.

The practical application of the process consists of putting the sewage in open outdoor basins called stabilization ponds. Stabilization ponds are easy to construct and are self-regulating and require practically no supervision. In favourable climate, stabilization ponds are cheap and efficient.

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Can genes be overlapping?

"GENES are enzymes" was a common opinion at one time. But the researches of George W. Beadle and Edward L. Tatum of the California Institute of Technology, California, led to an important and provoking concept that genes specify enzymes—the one gene-one enzyme hypothesis. The hypothesis is that each gene controls the reproduction, function and specificity of a particular enzyme. This hypothesis was later on modified as *one gene-one protein* hypothesis when it became clear that some genes control the formation of proteins which are not enzymes. However, the direct evidence that genes specify proteins was first provided by V. M. Ingram of the Cambridge University, Cambridge in 1957. His experiments led to a more precise definition that a gene is a segment of genetic material which specifies one polypeptide chain. Therefore, the one gene-one-enzyme theory was rephrased as one gene-one polypeptide chain hypothesis.

Genes in almost all organisms are composed of DNA which is the carrier of genetic information. In 1958, Francis Crick of the Medical Research Council of Cambridge proposed a hypothesis that DNA determines the sequence of amino acids in a polypeptide chain. There are 20 different amino acids which are bonded together by peptide bonds to give rise to polypeptide molecules. In a polypeptide (or protein) several hundred amino acids can be arranged in a specific order that is genetically determined. A protein therefore can be equated with a long sentence written in a language that has 20 "letters" (amino acids). The basic idea behind Crick's hypothesis was that DNA and protein are both linear structures. In DNA it is the sequence of different nucleotides and in a polypeptide it is a sequence of amino acids which is linear, If Crick's hypothesis was correct, then a mutational change in a particular position of the nucleotide sequence of DNA should reflect itself as a change in a corresponding linear position in the amino acid sequence of the polypeptide. For instance, four nucleotides A, B, C and D in DNA linked in that order, if mutated, should affect the amino acid sequence (a, b, c and d) in the same order.

In 1966 Charles Yanofsky and his associates of the Stanford University indeed found it to be so by experiments on an enzyme, tryptophan synthetase, of bacterium *E. coli*. They conclusively showed that each mutational site in a gene corresponds to a change of an amino acid. This was a strong evidence for the principle of colinearity. They further proved that two different mutations at nearby positions in a gene can produce a change in the same amino acid of the protein. This indicated that it is not only one nucleotide but a group of nucleotides within the gene that is responsible for the insertion of one particular amino acid into a polypeptide chain. The pioneering work of Marshall Nirenberg and Philip Leder of the National Institute of Health Maryland in 1964 and of Har Gobind Khorana and his associates of the University of Wisconsin, Madison in 1967 showed that a set of three nucleotides codes for an amino acid, i.e., the genetic code is a triplet (see also *S.R.*, February 1977).

Apparently the form of 3 nucleotides in a sequence of codons may be overlapping or non-overlapping. George Gamow of the University of Colorado in 1954 suggested that the genetic code is overlapping. Each base out of the three can be shared by the adjacent codons so that the end of the first triplet may form the beginning of the next. This would allow the production of more amino acids than there are the number of codons. For example, the sequence AGUCA which does not have even two complete codons could specify three amino acids; 1. AGU, 2. GUC and 3. UCA, if the code were overlapping. Also, in this case a single base mutation would change more than one amino acid. But the work of H. G. Wittmann of the Max Plank Institute for Biology, Tubingen, and of Tasugita and Fraenkel-Conrat at the University of California, on the single mutation in the protein of tobacco mosaic virus (TMV) showed that almost always only one amino acid at a time is changed. This clearly proved that the code is non-overlapping. Had it been overlapping, more than one amino acid would change due [illegible] m

Furthermore, many examples show that single mutation would cause only a single amino acid change in insulin, tryptophan synthetase, TMV coat protein, hemoglobin,

Fig. 1. The arrangement of nine genes in $\phi\times 174$. Gene B is "contained" in gene A and gene E is "contained" in gene D

etc. It has also been proved that only as many amino acids are coded as there are different sets of triplet codons. According to Monroe W. Strickberger (1976) of the University of Missouri, St. Louis : "all evidence to date indicates that single mutation affects only a single amino acid in a protein chain, meaning that the code is non-overlapping." As genes are definite sets of non-overlapping codons, each gene therefore is a separate entity, i.e., genes are also non-overlapping. In other words, each gene can be read in one way to produce only one polypeptide (or protein).

But recently Bart Barrell, Gillian Air and Clyde Hutchison III of the MRC Laboratory of Molecular Biology, Cambridge, made an epoch making discovery that a gene can be read in two different ways to produce two different proteins (*Nature*, **264**, 34, 1976). Working with a tiny virus φ×174, they proved that the genes can be overlapping. It was further shown that this virus contains not only one but two cases of overlapping genes.

φ×174 is a small icosahedral phage that infects and multiplies inside the bacterial host. It has a single stranded DNA molecule (as against a normal double stranded DNA) as its genetic material is distributed among 9 genes (named *A, B, C, D, E, J, F, G* and *H*).

Barrell and his colleagues used a recently developed "DNA sequencing" technique of Fred Sanger and A. R. Coulson of the MRC Laboratory of Molecular Biology, Cambridge, for analysing the chemical sequence of DNA of each gene. After analysis, they correlated the base sequence of DNA of the *D* gene with the amino acid sequence of its protein. They found that the "stop" codon of gene *D* overlaps the "start" codon of adjacent gene *J*. For instance, in the base sequence TAATG, the first three bases (TAA) function as the stop codon for gene *D* while the last three (ATG) provide the start codon for gene *J*. So it is at the third base A at which both genes overlap (Fig. 2).

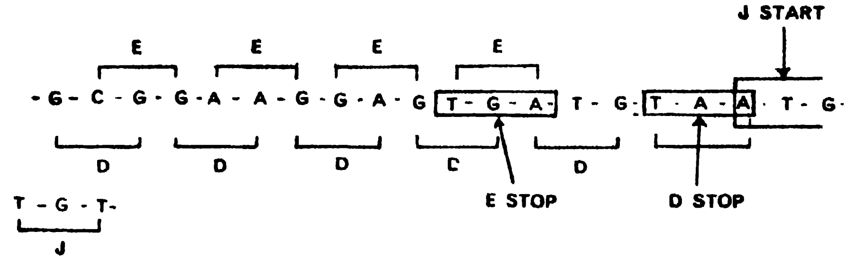

Fig. 2. The overlapping codes for genes D and E. The two gene sequences are shifted by one coding frame. The "stop" codon of gene D overlaps the "start" codon of gene J

However, the real problem they faced was to locate the position of gene *E*. A series of genetic tests indicated that gene *E* is completely "contained" within gene *D*—it was just unbelievable ! But the evidence obtained forced them to accept this unusual situation. They demonstrated that gene *E* has its own "start" and "stop" signals and further proved that this gene is coincident with the last 60% part of gene *D*. What, then, is the difference between the nucleotide sequence of genes *D* and *E* ? It was found that the two gene sequences are shifted by one coding frame, i. e., the first letter in a *D* gene codon is the last letter in *E*, and so on (Fig. 2). This type of adaptation is of course strange but is a great help to the organism because, by this mechanism gene *D* protein is made in greater quantities controlling the production of gene *E* protein.

Another case of overlapping genes has been found in φ×174 by Nigel Brown and Mike Smith also of the MRC Laboratory of Molecular Biology, Cambridge (*Nature*, **265**, 702, 1977). They found that gene *B* overlaps gene *A* (Fig. 2). Their work confirmed that *A* and *B* genes are transcribed from the same DNA sequence but using different reading frames.

This system of overlapping codons (or genes) suits very well the organism and gives it a great advantage. Overlapping segments economize on the space needed to pack up their genetic material into a small available protein coat of the virus and at the same time produce sufficient amounts of proteins needed. There are a large number of other small viruses like φ×174. Hence, it is expected that more cases of overlapping genes would be soon found.

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Teratogenicity in humans

MOST drugs are compounds with potent metabolic effects. Toxic reactions occur if too much of a drug enters the body. Teratogenic action of certain drugs is an undesirable and dangerous after-effect which can occur in humans when a drug is not taken in correct therapeutic dose or taken in over-dose. Toxic effects due to over-dosage are not being considered here.

Many chemical substances are known to have a capacity to affect cells of a developing embryo and produce congenital abnormalities. Some embryonic defects are incompatiable with life and cause abortion. Many other defects lead to a viable but abnormal full-term infant. The investigation of human teratogenecity is exceedingly difficult and has to be preceded by extensive studies with various animals. The drugs given in Table 1 are believed to be implicated in the induction of foetal abnormalities in humans following their administration during pregnancy. Deficiency of vitamin C, riboflavin, vitamin B_1, niacin, folic acid, panthothenic acid, vitamin A, D and E during pregnancy leads to foetal malformations. Consequently, malformations can also be induced by adequate intake of vitamin antagonists such as antifolate drugs, 6-aminonicotinamide or 3-acetylpyridine which would produce secondary deficiency of various vitamins. It has been found that maternal hypervitaminosis-A is strongly teratogenic, while large doses of nicotinic acid can also induce malformations.

Foetus is a rapidly growing tissue. So, any substance that interferes with its metabolism is likely to induce malformations. Anything that reduces the supply of oxygen is a potent teratogen. Malformations are common after relatively brief exposure of pregnant animals to carbon monoxide. All drugs acting on nucleic acid biosynthesis are teratogens, e.g., alkylating agents, base analogs, acridins, colchicine, etc. So are the general enzyme inhibitors such as lead, thallium, mercury, strontium and selenium salts. Hormonal relationship between foetus and the mother is complex. As hormones are the primary regulators of many types of metabolism, teratogenic effects are seen following hormonal imbalance during pregnancy. Increased incidence of malformations occur in deficiencies of pituitary, thyroid or pancreatic hormones, which are induced by damage to glands or following the administration of agents, e.g., progestogens, thiouracils and alloxan which block their secretions. Excess or high doses of thyroxine, corticosteroids, insulin, vasopressin, sex hormones and adrenaline are also teratogenic. Doses of cortico- steroids that are not themselves teratogenic- increase the incidence of malformations following vitamin A administration, but nonteratogenic doses of insulin have the opposite effect. Thyroxine also reduces the teratogenecity of vitamin A, but thiouracil compounds increase it. One of the best investigated human teratogenic drug is thalidomide which was first introduced in Europe in the late 1950s as a hypnotic and tranquillizer. As an anti-nauseant in early pregnancy, it produced a catastrophic increase in phocomelia, a condition in which arms and feet are attached directly to trunk giving a seal-like appearance. Thalidomide is metabolised in the body into a wide range of products, and it is suspected that one or more of the metabolites, rather than the parent compound, is the teratogen. The major metabolic pathways are given in Fig. 1.

Table 1. Teratogenic actions in drugs

Drug Name	*Example*	*Foetal abnormalities*
1. *Antibiotics*	(a) Streptomycin	(a) Nerve deafness
	(b) Tetracyclines	(b) Retarded bone age and discoloured teeth.
	(c) Chloramphenical	(c) Kernictens
	(d) Erythromycin	(d) Liver damage
	(e) Novobiocin	(e) Kernictens
2. *Tranquillizers*	(a) Phenothiazines	(a) Hyperbillrubinaemia
	(b) Meprobamate	(b) Retarded development
	(c) Reserpine	(c) Respiratory obstruction
3. *Steriod hormones*	(a) Corticoids	(a) Cleft plate
	(b) Progestogens	(b) Masculinization
	(d) Androgens	(c) Masculinization
	(d) Estrogens	(d) Advanced bone age
4. *Thyroids*	(a) Propylthiouracil	(a) & (b) Goitre & Mental hazards
	(b) Methimazole	
5. *Sedatives*	(a) Thalidomide	(a) Phocomelia
	(b) Barbiturates	(b) Neonatal bleedings
	(d) Morphine	(c) Neonatal bleedings
6. *Cancer Drugs*	(a) Aminopterin	(a), (b) & (c) death of foetus
	(b) Methotrexate	
	(c) Chorambucil	
7. *Diabetic Drugs*	(a) Sulphomylures	(a) Various abnormalities
	(b) Phenformin	(b) Lactic acidosis
8. *Anti-histamines*	(a) Medozine	(a) & (b) various abnormalities
	(b) Cyclizine	
9. *Anti-Malarials*	(a) Quinine	(a) Thrombocytopenia
	(b) Choroquine	(b) Retinal damage
10. *Diuretics*	(a) Thiazides	(a) Thrombocytopenia

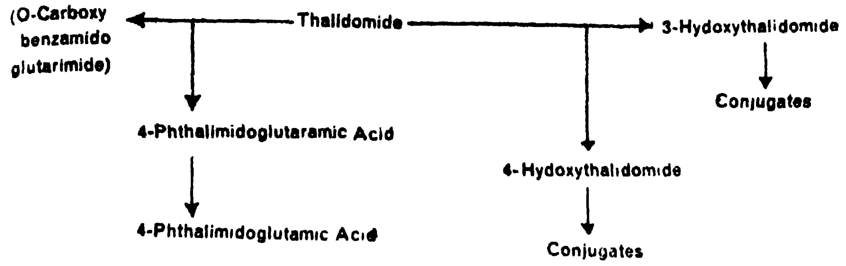
(O-Carboxy benzamido glutarimide)
Thalidomide
3-Hydoxythalidomide
Conjugates
4-Phthalimidoglutaramic Acid
4-Hydoxythalidomide
4-Phthalimidoglutamic Acid
Conjugates

Fig. 1. Major metabolic pathways

In humans the major urinary metabolite of thalidomide is 4-phthalimidoglutaramic acid, with small amounts of its deaminated derivative, but in dogs and rats the major metabolite is carboxy benzamidoglutarimide.

The 3 and 4-hydroxylated compounds appear in the urine of rabbits. It is believed by some that the glutarimide rings are not directly implicated in the teratogenic action of thalidomide. Studies on the effects of thalidomide and related compounds on rabbit foetus have revealed that among tested glutarimides only thalidomide and a nitroderivative manifest teratogenic activity. Two metabolites of thalidomide, phthalimide derivatives and those lacking the glutarimide rings are also known to be teratogenic. It is, therefore, concluded that the glutarimide rings are not implicated directly in the manifestation of the teratogenic action of thalidomide. The mode of action of thalidomide, or its metabilites, in producing foetal malformations is still uncertain, but it may involve acylation of nucleic acids

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Vegetable raw materials for drug industry

STEROIDAL drugs fall into three categories on the basis of their uses: corticosteroids, sex hormones, and antifertility compounds. Corticosteroids have been used for over 20 years in the treatment of cardiovascular diseases and as anti-inflammatory agents. Products such as cortisone and prednisone account for the largest part of total steroid consumption. Sex hormones are testosterone, estradiol and progesterone. Testosterone and its modifications are used to treat testicular insufficiency and as anabolic agents. Female sex hormones are used in the treatment of gynecologic disorders and as antifertility agents in oral contraceptives. Most oral contraceptives in use today are pills containing an estrogen (ethynyl estradiol and mestranol) and a progestogen (mostly 19-nor compounds and to a lesser extent derivatives of 17-hydroxy progesterone).

The total requirement of bulk steroids in the country is estimated to cost 375 million US dollars. Though the steroid industry in India had its beginning in early 1950s, Indian scientists did not pay adequate attention to exploit the natural forest wealth. Direct synthesis of a few finished steroids has been achieved chemically but this cannot compete economically with their synthesis from naturally occurring compounds. An informal survey of various pharmaceutical companies and professional chemists has revealed that the total synthesis of basic natural compounds from steroidal skeleton is not possible at present. That is why some vegetable raw materials having economic feasibility have been recognized by the steroid industry.

The dioscoreas

Diosgenin, obtained from tubers of different species of *Dioscorea*, is the all important ingredient of the steroidal drugs. Of the 600 existing species, the principal sapogenin bearing species are: *D. balcanica, D. belizensis, D. composita, D. deltoidea, D. floribunda, D. friendrichthalii, D. glauca, D. hondurensis, D. mexicana, D. prazeri, D. spiculiflora D. sylvatica* and *D. villosa*. In India, out of 50 species *D. deltoidea* and *D. prazeri* from the North-Western and North-Eastern Himalayan regions respectively are commercially important. *D. deltoidea* contains higher quantities of diosgenin (4.9% to 8.0%) and grows wildly in Jammu and Kashmir and Himachal Pradesh. *D. prazeri* containing 2.0% to 4% diosgenin grows wild in West Bengal Himalayan hills, Bhutan, Sikkim and Nepal. Large scale cultivation of *D. deltoidea* has been undertaken by Central Indian Medicinal Plants Organisation, Lucknow in the north-western hills and that of *D. prazeri* by West Bengal Government Medicinal Plants Directorate in Darjeeling. Cultivation of non-Indian *Dioscoreas* like *composita* and *floribunda* has been undertaken by CIMPO around Bangalore and other places on a contractual basis The cost of diosgenin has gone up from Rs. 100 per kg to Rs. 130 per kg or more.

At present only about 80 hectares are under cultivation with a capacity to produce diosgenin to the tune of 30 tonnes annually. About 1000 hectares will be required for cultivation of *Dioscoreas* to make enough diosgenin, i.e., about 100-150 tonnes annually to meet the demand for the production of various steroids. To encourage domestic processing, government has imposed a ban on the export of *Dioscorea* and diosgenin.

The solanums

Solasodine (a gluco-alkaloid) is obtained from various species of *Solanum* and the most economic ones are: *S. khasianum*, *S. eleaegnifolium*, *S. incanum*, *S. indicum*, *S. mammosum*, *S. pubescence*, *S. seaforthianum*, *S. surratense*, *S. lacinatum*, *S. aviculare* and *S. trilobatum*. Among these, *S. khasianum* has attracted much attention on account of its high potential both in terms of yield of berries as well as solasodine content. Being an aggressive plant, it produces a good stand even in the marginal lands but demands intensive care. Under proper management two crops can be raised annually assuring a steady supply of raw materials to the steroid industry.

The Costus, Balanites and Kalsroemia

Attempts have been made in recent years to provide the indigenous steroid industry with other favoured raw materials. This has led to the discovery of some steroidal drug yielding plants. *Costus speciosus*, *Balanites roxburghii* and *Kalstroemia pubesens* have been recognised as steroidal raw materials of commercial feasibility. The diosgenin content of *Costus* is 2.1%, of *Balanites* 2.0%, and of *Kalstroemia* 1.8%. *Costus* grows in wild condition throughout India. Out of about 60 species, only *Costus speciosus* contains sufficient diosgenin. Commercial cultivation of this plant has been undertaken by RRL, Jammu and Govt. Medicinal Plants Directorate, West Bengal. The other two genera are still left in wild as they are very recent discoveries.

The agaves

Investigation on hecogenin content of Indian *Agaves* and wastes of the sisal rope industries of West Bengal and Orissa have been encouraging. The plants are important in two aspects: for sisal fibres and for hecogenin, a basic compound for the steroid industry obtained as a byproduct from the pulp. The main species are: *A. sislana*, *A. cantal*, *A. veracuza* and *A. lechequilla*. The *Agaves* are cultivated in South India and in the State government farms in West Bengal for fibres. The hecogenin obtained as a byproduct serves as a common intermediate for the production of triamcenelone, betamethasone and dexamethasone. There are analogues of corticosteroids used extensively in pharmaceutical preparations of anti-inflammatory and anti-allergic agents.

Miscellaneous botanical resources

In the late forties, stigmasterol appeared to be a very useful steroid intermediate and it was observed that seeds of two Indian plants, *Dolichos lablab* and *Vigna catjang*, were useful materials for production of stigmasterol. But at present it has lost its importance due to the availability of established sapogenins like diosgenin and some gluco-alkaloids solasodine, etc. Of the other less economic botanical resources of steroidal industry, mention may be made of *Trillium govanianum*, *Paris polyphylla*, *Cestrum nocturnum*, *Smillax ornata* and *Yucca* spp. Besides, β-sitosterol which is obtained from abundantly available industrial wastes like sugarcane, and soft wax offers a distinct alternative to more expensive and less easily available diosgenin and solasodine. Recent developments in microbiological transformations as well as improved techniques have made β-sitosterol a promising candidate for steroid synthesis.

It is encouraging that the Indian steroid industry has started production of steroid sex hormones, corticosteroids and non-steroid oral contraceptives based on diosgenin of *D. deltoidea* of Kashmir, Punjab and Himachal Pradesh; *D. prazeri* of West Bengal Himalayan hills, Nepal, Sikkim and Bhutan and *D. composita* and *D. floribunda* of various cultivated areas in India. The industry is still depending mainly on wild collection of the yams from the hilly forest regions, but fresh attention is being paid towards cultivation of diosgenin-rich *Dioscoreas* and even for development of new diosgenin-rich strains. As the overall comparative economics and maintenance of proper balance with other essential requirements of the country are important, diosgenins from wild *Dioscoreas*, cultivated *Dioscoreas*, *Costus*, *Kalstroemia* solasodine of *Solanums* and hecogenin of *Agaves* have to face a serious competition amongst themselves. There is also the possibility of economic tissue culture of *Dioscorea* and other plants for diosgenin. It may even be possible to develop a microbiological method of production of diosgenin. While the industry will be busy in utilizing the best material available at present, future researches may bring to light newer and better raw materials for the purpose.

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Insect galls

DURING spring or early summer, while passing through a forest or a garden, we sometimes come across beautifully coloured outgrowths on plantroots, stems, leaves and flowers. These outgrowths vary in colour from gray or white, pale or dark green and yellowish green to bright orange, brown green to bright orange, brown red and deep violet. These outgrowths are known as galls.

A gall is an abnormal growth of a plant tissue caused by chemicals introduced on the plants by insects, mites, nematodes or fungi. The occurrence of galls is well-known but its nature was not discovered until recent times. Marcello Malpighi (1626-94), the Italian anatomist, was the first to give an explanation of this phenomenon in his treatise "De Gallis."

Insects are the chief causative agents of plant galls. As many as six orders of insects, viz., Coleoptera, Lepidoptera, Homoptera, Thysanoptera, Hymenoptera and Diptera are individually involved in gall formation. The gall insects attack almost all parts of plants, namely, buds, petiole, flower head, stem, bark, leaves and roots. The gall serves as a shelter for larvae as well as pupal stages. The gall also protects adult insects from predators and parasites.

Galls are generally of two types—open and closed. The open galls are produced by an insect with haustellate mouth parts, e.g., aphids, psyclids, coccids. They feed outside but ultimately the leaf folds or grows inwards to form a pocket in which the insect lives and feeds. After completing the life cycle, the young ones emerge out of small pore on the lower surface of the leaf.

Closed galls are made by larvae of mandibulate insect. This type of gall is produced by the larvae of the order Coleoptera, Lepidoptera, Diptera and Hymenoptera. The larvae in this type have mandibulate mouth parts and they feed on plant tissue.

Most of the galls are simple or monothalamus, i.e., containing a single larvae Some are however found to be compound or polythalamus i.e., each gall containing several larvae in separate cells or chambers.

Galls can be further classified on the basis of their formation and texture. The blister galls are shallow. They are produced by cecidomycide. The spagle galls like shallow serueers present on the ventral surface of the leaf are produced by cecidomycide and sometimes by cynipidae. The bottom galls result from the action of cynipidae. The tube galls are again produced by cecidomycide. A large number of galls are produced by egg laying insects like cicadus, tree hoppers, etc.

Our knowledge about the formation of plant galls has increased significantly in the last two decades. It has also gained a considerable significance in the investigation of the etiology of animal and human cancer.

The galls are pathologically developed cells, tissue and organs of plants, resulting from hypertrophy or overgrowth and hyperplasty or excessive cell division. The gall-insects lay their eggs upon the host plants and usually there is no growth till the egg hatches. The mandibulate insects feed on the plant tissue while haustellate insects suck their juice and enzyme produced by the insect. This changes starch of the plant into sugar. The production of excess food stimulates protoplasmic activity of plant cells which leads to the formation of galls.

Tannic acid is one of the chief products obtained from galls. Galls are also useful in obtaining various types of dyes, as they are beautifully coloured Galls have been used in medicine; their use in controlling diseases is mentioned in various pharmacopoeias. In some eastern countries galls are occasionally used as food.

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Newts of Manipur

DIFFERENT animal species are found in Manipur (Max. Temp. 39° and Min. Temp. 0°) The varied geographical factors contribute to the luxuriant growth of plants and animals here. Some rare forms of animals, like Brow antler deer, Horn bill, limbless lizard and some unique fresh water fishes are also available Among amphibians, the rare species available is the *Tylototriton verucosus*, which is one of the four species reported in eastern Asia (Sub. Fam *Salamanadrine*)

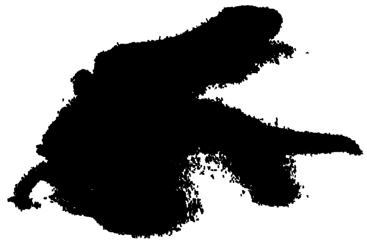

Fig. 1. *Tylototriton verrucosus* **in the laboratory**

The occurrence of this species in the forests of Himalayas and Darjeeling has been reported by Murthy (*S. R.*, August 1976).

In Manipur, this rare species is available at Ukhrul (8000 ft. to 11,000 ft.). There it lives in ponds ditches, paddyfields under the moss of rotten leaves, in the roots of old trees, in cracks and clefts of the ground, under heaps of stones or in the holes dug by mice. An essential requirement of their living is moisture. During rainy season, they come out of their usual places and are found even on roads. They are aquatic only during breeding season, after that they become terrestrial, hide in cracks, vegetation or in the sandy soil where there is enough moisture without heat.

The body measures about 142 mm in male and 175 mm in female. The head is as broad as it is long and snout is rounded. Limbs are short and weak, with 4 toes in the anterior limbs and 5 in the posterior No webs in between the toes indicate they are terrestrial in their habitat.

In the laboratory, when the animal is kept in an aquarium containing partly immersed stones, some annelids, arthropods and certain water plants, it rests on the stones motion less for a long time. It goes into water for taking food.

The tail of the animal is long and laterally compressed. The mouth is wide and semicircular. The eyes are narrow and have eyelids. The skin is rough. The head has a prominent, inverted 'V' shaped ridge, the gular fold, touching the upper surface of the eyes.

At the centre of the ridge near the base, there is a short parietal ridge. The body colour is blackish-brown above and pale on the ventral surface.

The Government of Manipur has taken steps to protect this rare species from destruction.

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Indian vegetable gums

VEGETABLE gums constitute an important group of natural plant products. They have remarkable binding and jelly forming properties and have been used as adhesives and in confectionery. The gums are obtained as exudations from natural or artificial cuts in the bark of a large number of trees and sold in market in the form of transluscent globules or crystals. It is believed that gum is a part and parcel of the normal metabolism of the plant and is in every sense a natural or physiological rather than a pathological product.

Vegetable gums have a wide and varied use in home and industry. Gums are also used as food by aboriginals in India, West Asia and African countries. In Australia, Wattle gum is a well-known food of the aboriginal tribes. The bulk of the gum is however used in modern day industry as ingredients of pastes, polishes, syrups and other cosmetic and confectionery items. They have an extensive use as a clarifying agent in sugar, wine and beverage industry, as sizing material in paper and textile industry, in the manufacture of printing inks and for imparting transparent finish to the artificial fibre. A number of gums have been found quite effective in the treatment of asthma, diarrhoea and other gastro-intestinal disorders, in sexual debility, as soother in throat irritation and as tonic during pre and post-natal conditions in women. In pharmacy, tragacanth gum is used as an adhesive for pill and tablets and as suspension of insoluble powders. World's major producers of gums are North America, Australia, India and certain South American countries. India exports large quantities of gums of which the Karaya and Guar gum form the bulk.

Occurrence and origin

Gums are widely distributed in the vegetable kingdom. Various parts of plants produce or secrete them. A number of species of certain families of flowering plants are free gum yielders. Notable among them is *Leguminosae*, in which about 150 species belonging to genus *Acacia*, *Albizzia*, *Bauhinia*, *Butea*, *Caesalpinia*, *Ceratonia*, an *Pithecellobium* are gum producers. Other important gum-yieldin families are *Anacardiaceae*, *Cochlospermaceae*, *Combretaceae*, *Euphorbiaceae*, *Meliaceae*, *Moringaceae*, *Rosaceae*, *Rutaceae* and *Sterculiaceae*.

Properties of vegetable gums

Physical properties like colour and form, taste and smell, hardness and density, polarization, solubility, viscosity, tenacity and colloidal nature vary considerably with gums of different botanical and geographic origin. It has also been shown that there may be noticeable difference in the gum from the same species when collected from plants growing under different climatic and edaphic (soil) conditions. Chemically, gums are complex acids built up of a nucleus acid combined with several of the less common sugars. Among the nucleus acids are arabic acid, geddic acid and bassoric acid. The work done in the earlier part of the last century led to recognition of three basic gum substances namely arobin cerasin and bassorin, believed to be individual chemical compounds, present individually or together in all gums.

Gums of Indian origin

About 45 species belonging to 10 plant families occurring wild in India are known to exude gum. The following are of commercial importance.

Indian gum arabic or "Babool" gum. It is obtained from natural cracks or artificial incisions or from wounds in the bark of *Acacia nelotica*. (vern. *Babool, Kiker*) a small-sized tree naturalised in all parts of India. The gum occurs in the form of rounded or ovoid tears of pale-yellow or dark brown colour (Figs 1 & 2) The *Babool* gum is frequently called gum arabic but it is an inferior substitute for true gum arabic obtained from *Acacia senegal*, imported from African countries

Babool gum is used in various diseases such as diarrhoea, dysentery, irritation of throat, as a protective in cases of superficial excoriation, ulcers, burns and sore-nipples.

Guar gum This gum is obtained from seeds of *Cymopsis tetragonaloba*. The plant is probably indigenous to India though it has never been found in a wild state It is cultivated throughout the country. There are several varieties distinguished by the height of the plant and the size and shape of the pods. Two varieties are recognised, i.e., giant and dwarf. The former is commonly grown in Gujarat while the latter is more popular in Punjab and Uttar Pradesh.

The seed flour of guar is the commercial source of the gum. It is used in food and textile industries. The gum containing portion is separated from the outer coat of the seed through milling. The soluble part of the guar flour is employed for backing postage stamps, improving the strength of certain grades of paper and tissue sheets.

Karaya gum. It has become very prominent in recent years as a substitute for gum tragacanth. About two tonnes of gum is exported annually under three different grades, i.e., white, pink and black. The gum is obtained from *Sterculia urens* (vern. *Karrai, Ponaku*), a large deciduous tree, common in mixed forests of north-west and central India. The gum is obtained through incisions made in the heart-wood of the tree during premonsoon months. It is sold under a variety of names, i.e., Karaya, Kadeya, Katira, Katillo, Kullo, Indian gum and Sterculia gum (Fig. 3). It is used in textile, cosmetic, cigar, paste, sweetmeats and ice-cream industries.

Katira gum. It is obtained from *Cochlospermum religiosum* (vern *Katira, Kongu, Kongilam*), a medium-sized deciduous tree occurring in Garhwal, Bundelkhand and West sub-Himalayan tracts, Bengal, Bihar, Orissa, Central India and Deccan Peninsula (Fig. 4). This gum is similar in appearance and properties to Karaya gum and is often known by the same name and used as a substitute for tragacanth gum obtained from *Astragalus gummifer* It is used as an adhesive in drug and pharmaceutical industry

Tragacanth gum. Of tragacanth yielding species in India, only

Figs. 1. Arabic gum; 2. Babool gum; 3. Karaya gum; 4. Katira gum; 5. Sahanjana; 6. Cherry gum

Astagallus strobiliferous has been reported to occur in Chitral and adjacent localities of Ladakh. Gum is obtained by making incisions usually on the bark of the stem. It can be successfully cultivated in Kishtwor and Kargil areas of Jammu & Kashmir and can earn a lot of foreign exchange for the country as there is a great demand for this gum in Europe and U.S.A.

Bengal Kino gum or Palash gum. It is one of the important medicinal gums obtained from natural cracks or artificial incisions in the bark of *Butea monosberma* (vern. *Palash, Dhak*) found throughout India. It is collected during summer months, specially when the tree is in flowers. It hardens into a vitreous, ruby red gum. It is a powerful astringent and is given in diarrhoea and dysentery.

Jhingan gum. It is extracted from the bark of *Lannea coromandelica* (vern. *Jhingan, Kaimbal*), a moderate-sized to large deciduous tree found throughout India and up to an altitude of 1500 m in the Himalaya. Mucilagenous in nature, the Jhingan gum exudes from wounds and cracks in the bark. In north India, the gum is tapped from March to the beginning of rains. The gum occurs in round tears or colourless, fissured angular fragments like gum of arabic. This gum is used in calico-printing along with the gum of *Anogeissus latifolia* It is also given internally in asthma and as a cordial for women during lactation.

Sahanjana gum. It is obtained from cuts in the bark of *Moringa oleifera* (vern. *Sahanjana*). The tree is indigenous to north-west India and is plentiful in alluvial land or sandy beds of rivers and streams. The gum is white in colour when fresh but changes to reddish-brown on exposure (Fig. 5). It is sparingly soluble in water but swells in contact with it giving a highly viscous solution. Major industrial application of the gum is in local calico-printing. Medicinally, it is used in earache, headache and is also given in syphilis and rheumatism.

Cherry gum. It is obtained from various species of *Prunus*, a large genus of deciduous or evergreen trees and shrubs distributed over the temperate regions of the northern-hemisphere (Fig. 6). Many species are in cultivation for their edible fruits and a few for their edible seeds. About 19 species occur wild in India. In western countries, a number of trees belonging to genus *Prunus* are exploited for gums, but in India no attention has been given in this direction. Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh are major producers of temperate fruits. The main trees grown are cherry (*P cerasus*), almond (*P. amygadalus*), plum (*P domestica*), apricot (*P. armeniaca*) and peach (*P. persica*).

Kathbel gum or Feronia gum. It is obtained from *Feronia limonia.* (vern. *Kathbel*), a large deciduous trees, common component of mixed deciduous forests, throughout the plains of India, particularly in dry situations. From the trunks and branches of the tree exudes gum in irregular semi-brown to pale-yellow or colourless tears resembling gum arabic in properties.

Ghatti gum. The true source of this gum is *Anogeissus latifolia* (vern *Dhava*) a large or moderate sized tree characteristic of dry deciduous forests throught India. The tree yields a gum which occurs in straw-coloured vermiform tears. It is a good substitute for gun arabic and is used for pharmaceutical purposes.

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Mate selection in toads

DURING the breeding season toads and frogs are found in amplexus—a breeding posture in which the male clasps the back of the female by gripping her pectoral girdle with the forearms. Does a female frog choose a male frog for mating ? Or, does mating take place at random ? For an answer, N. H. Davies and T. R. Halliday of the University of Oxford (*Nature*, Vol. 269, 1977, pp. 56-58) observed the toad, *Bufo bufo* in a pond near Oxford. Almost every female in the pond was in amplexus. However, male toads were in excess. Perhaps because males can mate more than once, they spend most of the breeding season in ponds. Less number of females in the pond might be due to the fact that they can spawn only once in the breeding season and so visit the pond for a shorter period.

The researchers measured the snout-vent length of males and females in amplexus. Before spawning, however, small males were just as likely to be paired with large females as were the larger males. But by the time spawning started, the larger males were paired with larger females. How did this change occur from random to non-random selection during mating? In laboratory observations researchers found that even males 30 mm smaller than females maintained amplexus with the female for a week or more. They, therefore, assumed that even a large female cannot replace a small male. They performed "male-male competition" experiments and found that likewise in the wild pairing occurred from random to non-random (Fig. 1). The researchers concluded that as a female is responsible for the locomotion of the mating pair, a big female with a small male in amplexus might swim amidst a group of males to start "male-male competition". The result then could be bigger male driving away the small male. Such a non-random mating ought to have some biological significance. For example, it is known that a male has the problem of timing his release of sperms in synchronisation with the release of ova by the female. For an efficient fertilization it is necessary that sperm-release and spawning are timed properly. So, it is likely that non-random mating is of definite value to *Bufo bufo* for increasing efficiency of fertilization by way of exact timing and proper release of sperms over the ova discharged by the female.

ZAKA IMAM

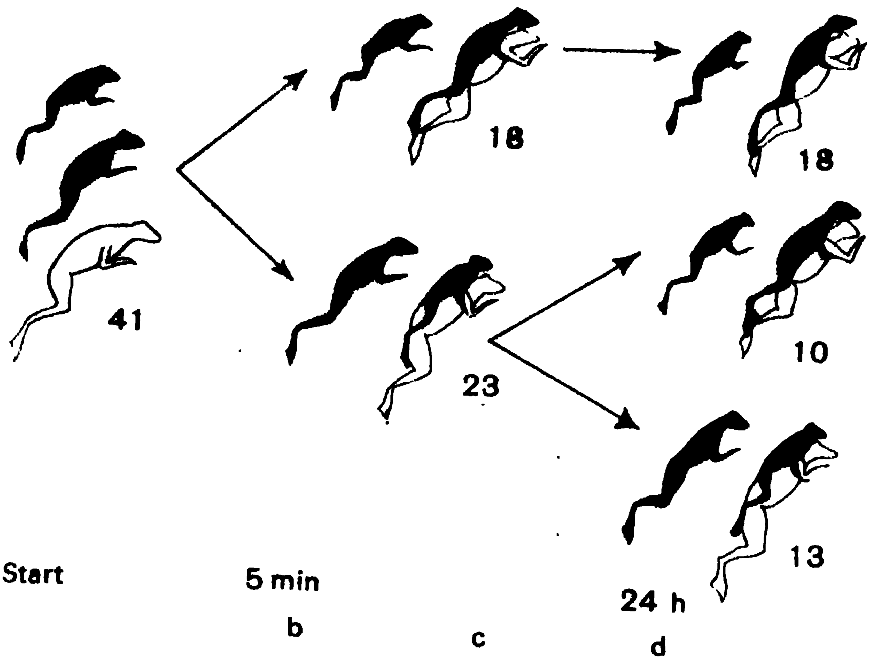

Fig. 1. Male-male competition experiments in toads. Large males somet. the small ones. Numbers indicate experiments performed in a tank

MERCK

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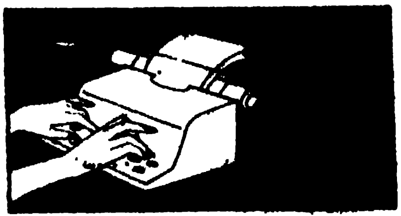

NEWS & NOTES

Dr. Fieser passes away

DR. Louis Frederick Fieser, Emeritus Professor of Organic Chemistry at Harvard University, coauthor (with his wife Mary Fieser) of the famous *Text Book of Organic Chemistry*, died on July 25, 1977 in Cambridge, Massachusetts, at the age of 78. He was also credited with the development of vitamin K, a blood-clotting agent, cortisone, the life-saving hormone for treatment of rheumatoid arthritis, and napalm, a jellied gasoline component of incendiary bombs and flamethrowers.

Born on April 7, 1899 in Columbus, Ohio, Fieser attended Williams College and received a Ph.D. degree at Harvard University in 1919. Author or coauthor of more than 300 research papers and eight books, Dr. Fieser was known in the scientific community as the "grand old man of organic chemistry." He won national and international awards for his development of vitamin K, cortisone and napalm as well as for his research on the chemical causes of cancer. He developed the theory that carcinogenic chemical may be subjected in the body to one or two (few) competing chemical reactions. He inferred from it that some ways might be found to prevent cancer. Dr Fieser was in the research team that helped find a missing oxygen link in the cortisone molecule.

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Interview

Dr. Dewan S. Bhakuni

NOW a Bhatnagar Award winner for his researches in chemical sciences, Dr. Dewan S. Bhakuni is a genuine product of our land. Son of a farmer, he had his schooling in a village near Almora, U.P. hills, and for only M.Sc. did he go to a town, Allahabad. He took Ph. D. from London University and D. I. C. from Imperial College of Science & Technology, London. His is a case for our brilliant rural lads to follow.

Part of the Dr. Bhakuni's credit to receive the country's most distinguished scientific research award certainly goes to his father. His ambition was to give his child good education. Hard work along with success encouraged young Bhakuni persue knowledge. He enjoyed doing experiments in the college laboratory and decided to become a scientist. "I think", he says, "if we do our work with devotion, people do appreciate it." And this was how he kept pursuing his goals. He says, "I have been encouraged by those who believe in work." To illustrate he tells how his dream to study abroad materialised.

"I was keen to work especially with Prof. D. H. R. Barton (later to get the Nobel Prize in 1965) at Imperial College of Science & Technology, London," he reminisced," but my financial resources were meagre. I nevertheless wrote to him expressing my intense desire to work with him—and he agreed to take me, offering me a scholarship !" This was the turning point in his life, he added. In fact, it was Prof. Barton who introduced him to alkaloid biosynthesis in which field Dr. Bhakuni is now considered as one of the pioneers in the country.

Dr. Bhakuni has been awarded 1975 Bhatnagar Award for his outstanding contributions to several aspects of chemistry of natural product. He has systematically examined a large number of indigenous medicinal plants for biological activity. He has also isolated from them several biologically active compounds. The structure, stereochemistry and absolute configuration of these compounds have been determined. His studies have revealed biological activity in a number of new natura products. Some of these structure have been given new leads for synthesising potent drugs.

With the help of tracer technique Dr. Bhakuni has shown how natur makes biologically active comple molecules. Using radio and opt

Dr. Dewan S. Bhakuni

cally active precursors he has studied stereospecificity of enzymatic reactions. He has successfully synthesised in the laboratory some biologically active compounds by taking cues from nature.

In 1972, Dr. Bhakuni went to South America as a Visiting Professor to work at the University of Concepcion, Chile. There he examined marine fauna and flora which are considered one of the potential sources of drugs. He also examined systematically Chilean flora for biologically active compounds.

Presently a scientist with Central Drug Research Institute, Lucknow, Dr Bhakuni thinks that 'education should be pragmatic. Emphasis should be given to develop thinking.' In so far as scientific career is concerned he claims that "it is full of excitement. It, however, demands devotion and sincerity of purpose."

Dilip M. Salwi

Acrylonitrile plastic bottles are harmful

RECENTLY the U. S. Food and Drug Administration (FDA) banned the use of plastic beverage bottles made from acrylonitrile. This step was taken after beers, soft drinks and fruit juices were test-marketed in acrylonitrile bottles for several months in the U.S.A. The current order applies to any beverage in the bottles. Leaching or solubilization of acrylonitrile into the product the bottles contain, was cited as the reason of the FDA's ban. Test animals fed with large amounts of acrylonitrile in their drinking water, had significantly lowered body weight and other adverse effects including lesions in the central nervous system and growths in the ear ducts, the FDA said. However, the amount of acrylonitrile fed to experimental animals in these tests exceeded by far the amount to which any consumer would be exposed from present use of acrylonitrile food containers or wrappings. The FDA announced that it was proposing to lower the maximum amount of acrylonitrile permitted to leach into the product from acrylonitrile wraps and other non-beverage packing. The decrease would be from 300 parts of acrylonitrile per billion parts of product, which is presently permitted to 50 parts per billion.

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Fifth International Congress on Hormonal Steroids—1978

THE Fifth International Congress on Hormonal Steroids will be held in New Delhi from Oct. 29—Nov. 4, 1978. The Endocrine Society of India has sponsored this Congress.

The Congress will deal with various aspects of hormonal streoids, their chemistry, newer analytical methods for their determination, their role in reproductive biology, their biosynthesis in various endocrine organs, their use as contraceptives, metabolism and metabolic effects of steroids, the role of steroids in neuroendocrine functions, their interrelationships with prostaglandins, proteins and other cyclic nucleotides.

The Congress is expected to attract about 2000 delegates, including about 300 to 400 from within the country.

For details write to Prof. K. R. Laumas, Chairman and Coordinator, Deptt. of Reproductive Biology, All India Institute of Medical Sciences, Ansari Nagar, New Delhi.

Solar Energy Conference

"SUN: mankind's future source of energy" is the theme for the International Solar Energy Congress to be held in New Delhi from 16th to 21st Jan., 1978. The Congress is being organised by the International Solar Energy Society in collaboration with the Solar Energy Society of India and a number of departments and organisations. Among them are the Department of Science and Technology, Council of Scientific & Industrial Research, Ministry of Energy and Indian Council of Agricultural Research. UNESCO and Commonwealth Foundation are also among the sponsors.

The deliberations at the Congress will cover among other things :

(A) International and National Plans and Programmes: economic aspects; policy, social and implementation aspects;

(B) Solar radiation: energy storage; photochemistry photobiology & biomass;
Flat plate collector, including solar ponds & selective

(*Continued on page* 738)

MEDICAL NOTES

Are short-sighted children more intelligent?

A leading article, which appeared in the *British Medical Journal* (21st February, 1976, p. 415), put forth a possibility that myopic persons might be more intelligent than others. According to Catherine S. Peckham of London and her colleagues, children having short-sightedness (myopia) are more intelligent than others of the same age group (*Brit. Med. Journ.*, 26th February, 1977) This team of workers led by Dr. Peckham studied children who acquired myopia by the age of 11, their social background, growth and academic performance. This group was compared with children who had normal vision in both eyes.

Myopic children scored more than the control group as judged by tests of reading, arithmetic and general ability. These talents of myopic children were evident at seven years of age even before the onset of myopia. The findings confirm those of a previous study by J. L. Karlsson (*Med. Dig.*, **22**, 5, 1977, p. 7).

Peckham and her colleagues differ from the view that was held before that myopic children tended to be more academic because defective vision limited their participation in other fields. They believe that parental interest may play a more important role in the myopic child's academic attainments.

Since short-sightedness has a strong genetic basis, J. L. Karlsson postulated that the gene responsible for myopia has a stimulating action on the brain.

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Hair lead levels as indicator of atmospheric lead pollution

THE Monitoring and Assessment Research Centre (MARC), which is part of the "earthwatch" network of the United Nations Environmental Programme (UNEP), has placed lead (Pb) along with mercury, vanadium, cadmium, and DDT in the list of priority chemicals presently potential risks to the biosphere. The absorption of lead by the human body as a consequence of widespread lead pollution causes brain damage along with several other physiological and pathological changes. In children the harmful effects of lead poisoning are generally found to be more serious. Paints, accumulators, metal castings, and motor oil industries are some of the biggest sources of lead pollution. Petrol pump attendants and traffic constables are most susceptible to lead-poisoning.

At Aachen, two German scientists, W. Dresch and K. M. Fortmann have now found that atmospheric lead can apparently diffuse into human hair and cannot be removed by repeated washing with chelating agents. It was further observed that in the distal (older) portions of the hair, higher lead contents are deposited as compared to proximal regions. Their findings also suggest that hair lead analyses give values which are indicative of atmospheric lead levels. By means of electron microscopy and X-ray analyses of the human hair, the German scientists observed the presence of discrete "inclusions" which contained lead. For reliable indications of total lead exposure or poisoning, they have recommended either blood lead determination or simply hair lead analysis in the hair sections nearest the scalp (*Naturwissenschaften*, **63**, 436, 1976).

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Senile osteoporosis

OSTEOPOROSIS is one of the menacing problems of old age. It is characterised by loss of bone density due to excessive absorption of calcium and phosphorous from the bone and progressive loss of the protein matrix of bone which normally carries the calcium deposits. These changes usually result in pathological fractures which are common in old age.

Osteoporosis of old age is attributed to three factors, viz., (a) decreased sex-hormone secretion; (b) high calcium excretion as well as low absorption; and (c) insufficient physical activity. Since the female sex-hormone, oestrogen, has an important function in the formation of new bone, senile osteoporosis is more common among women over 40 than men. The clinical features include pain at various sites such as back, neck, etc. Fractures after minimal injury, called pathological fractures, are common.

There are several methods of treating senile osteoporosis. B. Lund, *et al.* (*The Lancet*, 13th Dec., 1975 p 1168) report encouraging results in the treatment of senile osteoporosis with 1-alpha-hydroxy-cholecalciferol, an active vitamin-D analogue.

A leading article which appeared in The *Lancet*, (24th Jan., 1976, p. 181) recommends active mobilisation, calcium and vitamin-D supplementation. If these dietary methods are not successful, oestrogen therapy may be started. It has to be started within three years of the menopause and this method has given appreciable results (*Brit. Med. Journ.*, 8th Nov. 1975, p. 307). This is also supported by a clinical trial conducted by R Lindsay *et al.* (*The Lancet*, 15th May, 1976, p. 1038) employing mestranol, an oestrogen, daily.

The hormone secreted by the parathyroid glands, the parathormone, which plays a key role in calcium metabolism, has also been tried in improving osteoporotic condition. J. Reeve *et al.* (*The Lance.,* 15th May, 1976, p. 1035) report that human parathyroid hormone administration also has produced considerable improvement in old patients suffering from oesteoporosis.

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BOOK REVIEWS (*Continued from page 743*)

various predictions of the theories have been discussed in detail and compared with the latest experimental information. This has been done consistently in most of the chapters. This is a positive aspect of the book. Mathematics is not much complicated and hence should not be difficult for post-graduate students to follow. However, for the understanding of the book readers have to be well versed with electrodynamics and special theory of relativity. The book under review should be able to remove the feeling that theory of general relativity is something mysterious.

K. BHARGAVA
A. K. KAVATHEKAR

BOOKS RECEIVED

THE FLORA OF BHOPAL (Angiosperms) by M. Oommachan, *J. K. Jain Brothers*, Motia Park, Sultania Road, Bhopal 462001. Pp.475, Rs. 110.00

FIRE SAFETY IN FACTORIES by K. K. Ghosh, *West Bengal Chapter of National Safety Council*, Available at The Book Depository, 4/1 Madan Street (Ist Floor), Calcutta-700013. Pp. 36, Rs. 5.00

3. **PUGWASH ON SELF-RELIANCE**, Editors: W. K. Chagula, B. T. Feld, A. Parthasarathi, Asstt. Editor: P. J. Lavakare, *Ankur Publishing House*, Uphaar Cinema Building, Green Park Extn., New Delhi-110016, Pp.340, Rs. 30.00
4. **INTRODUCTION TO SEMI-CONDUCTOR DEVICES** by K. J. M. Rao, *Oxford & IBH Publishing Co.*, 66, Janpath, New Delhi-110001, Pp 220, Rs. 16.00
5. **FOOD SCIENCE** by Brijn A.Fox & Allan G. Cameron, *Hodder & Stoughton*, Available at B. I. Publications, 359, Dr. D. N. Road, Bombay-400023, Pp.380, Rs. 39.20 (£ 2.45)
6. **OPTICS** by Ajoy Ghatak, *Tata McGraw Hill Publishing Co. Ltd.*, 12/4, Asaf Ali Road, 3rd Floor, New Delhi-110002, Pp.358, Rs. 31.50

SCIENCE FOR THE YOUNG

Know your television

IN the radio broadcasting system, a microphone converts sound into electrical impulses. These impulses are then amplified or made stronger. The amplified sound signal is called an audio signal. The audio signals cannot by themselves travel through space. So they have to be 'carried' by radio waves which are called the 'carrier'. At the radio station, the carrier radio wave is produced at a transmitting antenna. It is an alternating electric current which oscillates at quite a high frequency. When a radio station broadcasts on a frequency of 1000KHz, it means that current is flowing up and down the transmitting aerial 1,000,000 times every second (Hz=Hertz=cycles/sec and K=Kilo=1000).

For transmission, the audio or sound signal is impressed on the carrier wave. This is called 'modulation'. The transmitting antenna sends this modulated radio wave in all directions. The basic principle of radio transmission is represented by a block diagram as shown in Fig 1.

When the modulated radio waves reach the aerial of a radio receiving set, they produce the same back and forth current in it. If the radio is tuned to the same frequency as that of the transmitting station, the radio will amplify the receiving signal, extract the audio signals from the carrier wave (called demodulation) and finally change them again into sound. This is how sound travels all the way from the broadcasting station to the radio receiving sets.

The science of television deals with transmission of both sound and picture by radio waves. At a TV transmitting station, a TV camera first converts a picture into electrical impulses and then amplifies them. The amplified picture signal is called the video signal. The video signals, like audio signals, are then impressed on carrier waves of a much higher frequency. The two carrier waves are then combined and fed into the TV antenna. The TV transmitting antenna, therefore, simultaneously transmits the two different carrier waves having two different frequencies, one for carrying video signal and another for audio signal (Fig. 2). A complete TV signal is called a 'composite signal', in which the two carrier frequencies are kept at a fixed distance. It means that a TV signal occupies a bandwidth or range in the radio spectrum. Table 1 shows the two carrier frequencies specified for TV station (channel 4) in India.

Table 1

Frequencies in MHz.
(MHz=Megahertz=10^6 cycles/sec).

Picture carrier	Sound carrier
62.25	67.75

The video signal

In photography, a camera converts an optical image into a chemical replica. The lens of the camera focuses the image on the photographic film which is coated with a light-sensitive chemical. These chemicals change when light strikes them. The change is higher where the light intensity is higher. Thereafter, by the process of printing, the image impression is fixed on the film.

The job of the TV camera is three fold. First, it converts an optical image into an electrical image. Second, a scanning beam converts this electrical replica into a large number of electrical impulses. Third, these impulses are amplified to produce video signal.

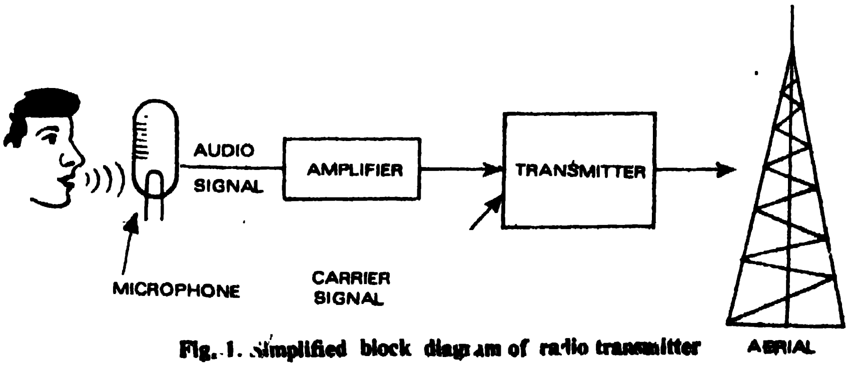

Fig. 1. Simplified block diagram of radio transmitter

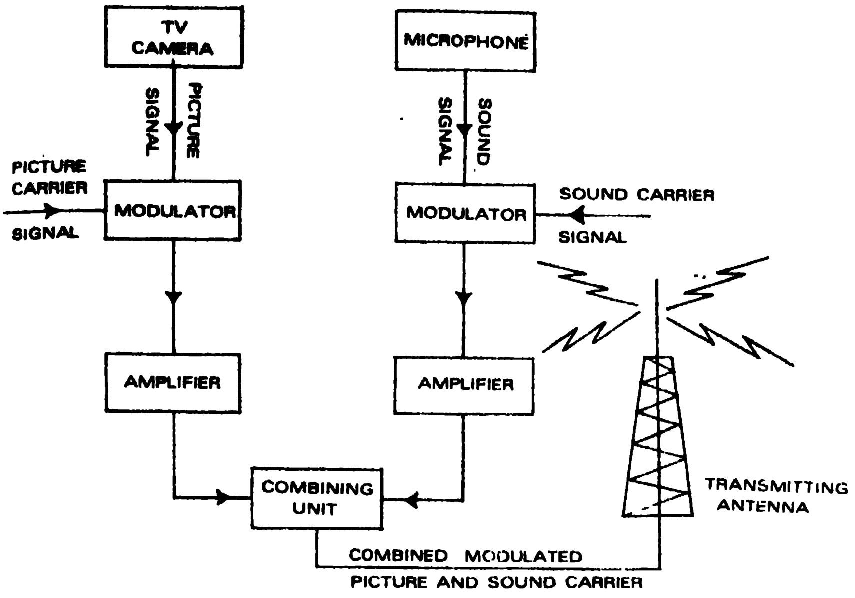

Fig. 2 Block diagram of TV transmitter

The two main types of camera tubes widely used today are the 'vidicon' and the 'image orthicon' Vidicon tubes are generally used in closed circuit TV cameras. For monochrome (black and white) TV systems, the image orthicon tubes are widely used.

The image orthicon tube

The image orthicon tube (Fig. 3) has a thin, light-sensitive layer coated on its inner surface. This is called photo-cathode which can emit electrons when light falls on it. When an image of a scene to be televised is focussed by an optical lens system on the front of the photo-cathode, it gives off electrons at the back. The number of electrons emitted depends upon the brightness of the image at that point. In other words, the density of electrons emitted at each point of the photo-cathode corresponds to the intensity of light at that point. The emitted electrons are accelerated and then directed towards a thin glass disc called the target. The target plate is not photosensitive but is capable of emitting many secondary electrons when accelerated electrons strike it. A positively charged fine-mesh screen is placed close to the target plate on the photo-cathode side. It collects the electrons emitted by the target. By losing electrons the target gets a net positive charge. It develops a pattern of positive charges directly proportional to the intensity of the arriving electrons. In this way an optical image is transformed into an electron replica.

The next section of the image orthicon tube is called the scanning section. Here the image replica is converted into electrical impulses. But the whole picture is not treated simultaneously. Each tiny speck of the image replica is changed into an appropriately strong or weak electrical signal. Again, this must be done in proper sequence so that the whole process may be reversed back and reproduced on the TV receiver screen.

An electron gun fires a finely focussed beam of electrons towards the target plate and a deflection system makes the beam travel back and forth (Fig. 4). The beam starts at the top left side and follows a slanting path from left to right across the target. After tracing the first line, the beam moves rapidly from right to the left hand side and starts to trace the second line, and so on till the bottom line is reached. Here the beam jumps rapidly back to the top and the process is repeated.

As it scans or moves over the positively charged replica of the image, the electron beam goes on depositing electrons to neutralize or discharge the positive pattern. At the surface of the target the beam stops its forward motion, turns back and forms the return beam. The intensity of the return beam is less than the incident beam depending on the number of electrons absorbed or lost on the target. The return beam is directed towards the multiplier section of the image orthicon tube, where it is amplified and finally leaves the tube through the anode producing the video signal.

This is how the picture is transformed into video signal, bit by bit, in orderly sequence.

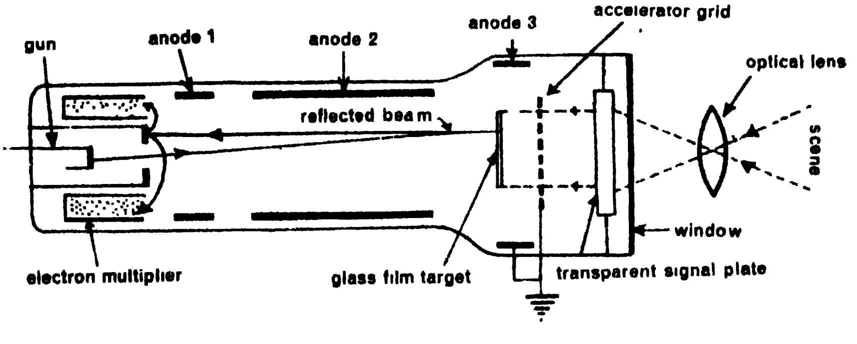

Fig. 3. Image Orthicon tube

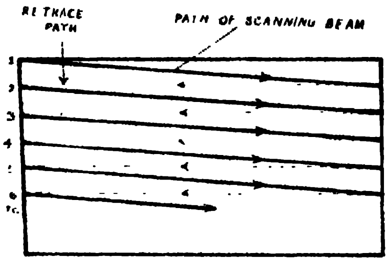

Fig. 4 The path of the scanning electron beam

Interlaced scanning

If an electric bulb is put on and off intermittently, the light flickers. But if the switching rate is increased, then, above a certain limit, the bulb will appear to glow steadily without flickering. This is due to a phenomenon called 'persistence of vision'. Due to this effect, the eye retains the impression of each glimpse for a short while. This factor is of considerable importance in TV. It decides the number of complete pictures or frames that could be scanned each second. The repetition rate should be such that, when reproduced on the TV screen, the action should appear continuous; there should be no flicker.

According to the standard TV transmission in India, the scanning beam in the camera tube traces out a total of 625 lines horizontally across the rectangular target plate. And in every second 25 complete pictures or frames are scanned. That implies that 625 × 25 = 15,625 lines are traced every second.

But when pictures or frames are reproduced on the TV screen at this rate, that is, 25 per second, the flicker is detectable. At the rate of 50 frames per second there is no flicker. So to eliminate all traces of flicker, 'interlaced scanning' system is utilised. The geometry of the pattern is illustrated in Fig. 5. Each frame is broken down into two $\frac{1}{2}$ frames called fields. In the first field the odd lines, $312\frac{1}{2}$ in all, are traced. For the second field, the beam returns to the top and the even lines, $312\frac{1}{2}$ in all, are traced. In this way, the two fields $(312\frac{1}{2} + 312\frac{1}{2} = 625)$ are interlaced in each frame. This technique presents an effective image frequency of 50 per second and therefore no flicker is noticeable.

TV receiver

After being picked up by the TV antenna, the signals travel down a cable to the TV set. Inside the set is the tuner which selects the signal and then amplifies it. The signal is next fed to a circuit, called the video detector, which extracts the picture component of the signal and then feeds it to the picture tube. The picture tube reproduces the video signals on its screen. A sound detector, on the other hand, extracts the sound information, amplifies it, and finally reproduces it through a speaker.

The picture tube

The most important part of a TV receiver is the picture tube that displays the picture. At the back of this tube is the electron gun - like the one in the camera tube. The gun directs the beam of electrons to the screen of the picture tube. The inside of the screen is coated with a fluorescent material which glows when struck by the electrons.

A picture tube is technically know as the cathode ray tube (CRT It has a filament that heats up th cathode to emit electrons. The ca thode is composed of tungsten (barium and strontium oxide. The control grid (Fig. 6) is a small hollow cylinder with a small pin-hole through which electrons may pa It controls the number of electr

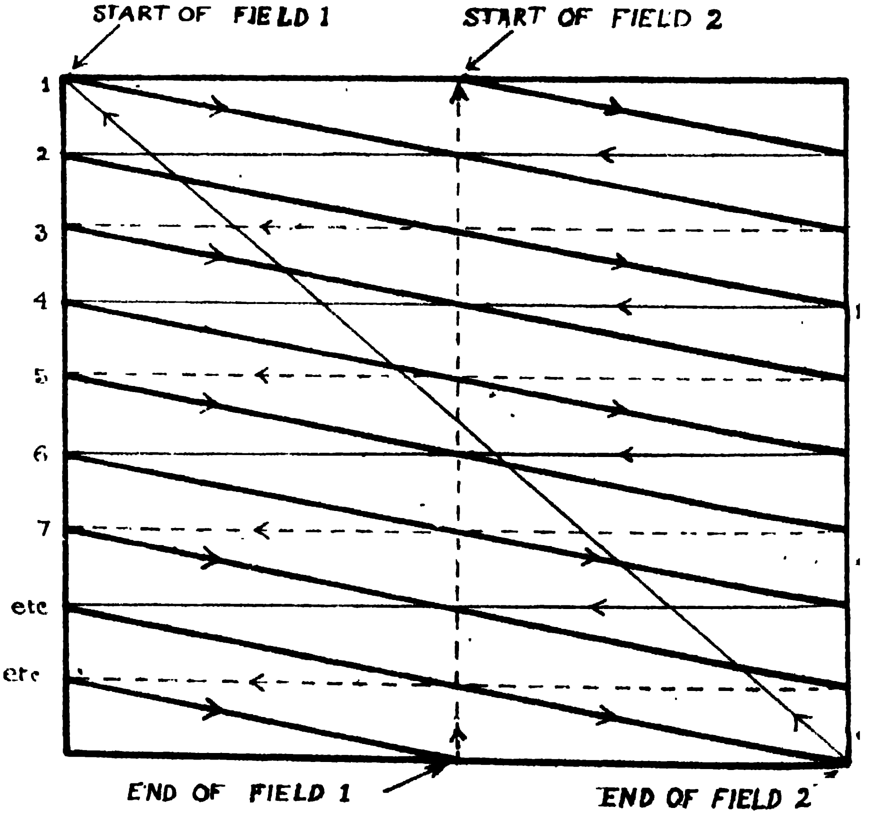

Fig. 5. The interlaced scanning

that flow towards the screen. A high negative voltage on the control grid can cut off the electron beam completely. A less negative voltage will allow the beam to proceed towards the screen. When the video signal is impressed on the control grid, it makes the beam intensity vary according to the signal.

The first anode is a hollow cylinder which is operated at a low positive potential. The second anode is another hollow cylinder which is maintained at a much higher positive potential (generally between 10 kV to 20 kV). The function of these two anodes is to converge and focus the electron beam on the screen. So only a tiny dot of light is produced on the TV screen. The brightness of this dot can be varied by changing the voltage on the control grid. In most picture tubes, the second anode is a black graphite coating on the inside of the glass funnel of the picture tube (called aquadag).

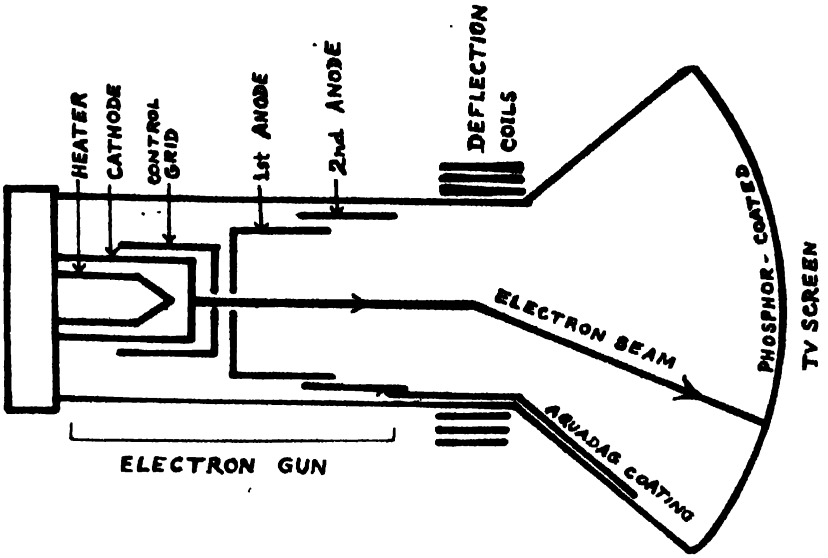

Fig. 6. TV picture tube

Beam deflection system

Just as in the camera tube, the electron beam in the picture tube is made to scan the screen. The scanning system in both cases operate exactly in the same manner and at the same rate, that is, 625 lines are scanned in a rectangular frame every 1/25 second. In every second we then see 25 frames. To remove all traces of flicker, 'interlaced scanning' is utilized. The bright dot therefore moves along the lines of the screen so fast that our eyes see only a complete rectangular frame which appears steady on the TV screen.

The movement of the beam or the dot is accomplished by two sets of deflection coils, placed at right angles to each other and mounted on the narrow neck of the picture tube. The entire assembly is called 'deflection yoke'.

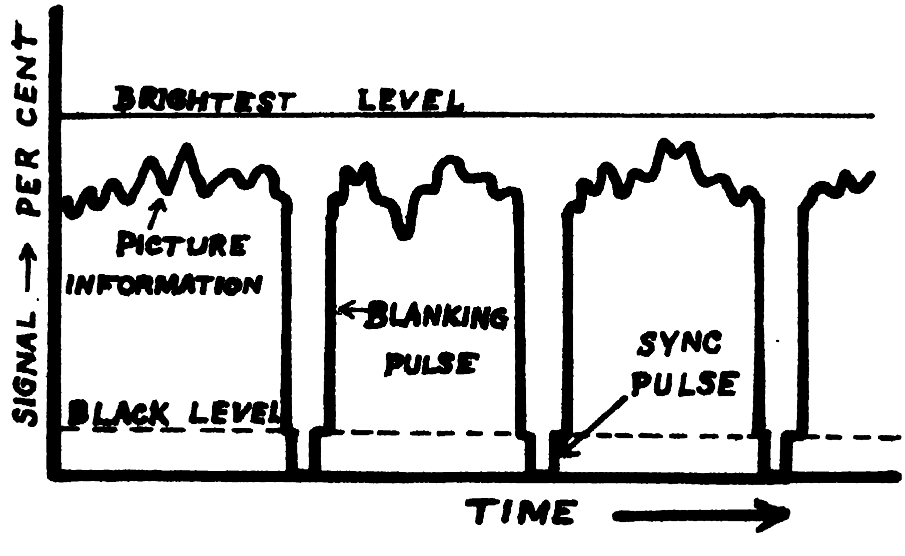

Fig. 7. Detected video signal

Blanking and synchronization

The video signal, when impressed on the control grid of the picture tube, controls the intensity of the scanning electron beam. The moving dot on the screen therefore changes continuously in brightness in accordance with the signal. The darker portions of the signal (more negative voltage on the control grid) reduces the intensity of the dot and the brighter portions (more postive voltage) increases it. The dot moves so fast that our eyes see only the complete picture on the screen.

It is necessary that at the end of every horizontal line the screen be momentarily dark so that the horizontal retrace lines do not appear on the screen. Similarly, the beam should be extinguished while it jumps rapidly back from the bottom to the top of the screen, to start tracing the first line of the next field. To achieve this condition, horizontal and vertical blanking pulses are added at the end of each video line which contains the image details (Fig. 7). When the video signal is applied, the control grid of the picture tube, these blanking signals prevent the electron beam from impinging on the TV screen during the retrace periods.

Again, it is absolutely necessary that the beam, which reproduces the picture on the TV screen, moves exactly in step with the beam forming the video signal at the transmitter. In other words, each line of the picture must exactly be in the right position on the screen so that each spot of light and darkness occurs in the right place. Otherwise, the picture will not be reproduced and instead meaningless dark and light areas will appear. The movement of both the beams, one at the transmitter and the other at the receiver, must be synchronized. To achieve this, synchronizing signals are superimposed over the blanking signal (Fig. 7). These signals control the current in the horizontal and vertical deflection coils and, in turn, control the position of the beam on the screen. In this way the electron beams in the camera tube and picture tube are kept exactly in step and the synchronization of the two beams is accomplished. Hence a faithful reproduction of the image is projected on the screen.

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Antibiotics

ANTIBIOTIC is a chemical substance produced by a microbial culture that is harmful in dilute solution to another microbe. This process has often been called antibiosis.

An antibiotic is a type of chemotherapeutic agent, i. e., it has toxic effect on certain types of disease-producing microbes without producing an adverse effect on a patient. Quinine used against malaria, arsphenamine used against syphilis, and the sulfa drugs used against a variety of diseases, notably pneumonia, are examples of chemotherapeutic agents. They differ from antibiotics in that they are not secreted by microorganisms as antibiotics are, but are produced synthetically in a chemical laboratory. A few antibiotics, including penicillin and chloremphenicol, have also now been produced synthetically.

The first observation of what would now be called an antibiotic effect was made in the 19th century by a French chemist, Louis Pasteur. He discovered that certain saprophytic bacteria can kill anthrax germs. Around 1900, a substance called pyconase was isolated from cultures of pus-forming bacteria by the German bacteriologist, Rudolf von Emmerich (1852-1914). Pyconase can kill the germs of cholera and diphtheria in test tubes. This discovery aroused much excitement but no success was obtained in curing the disease. In 1920s, a British bacteriologist, Sir Alexander Fleming, who later discovered penicillin, found a substance called lysozyme in many secretions of the body, such as tears and sweat, and in certain other plant and animal substances. Lysozyme has strong anti-microbial activity, but mainly against harmless bacteria.

Penicillin, the archetype of antibiotics, was discovered by accident in 1929 by Fleming. He showed its effectiveness against many disease-producing bacteria, such as those which produce gonorrhoea and certain types of meningitis and bacteremia (blood poisoning). However, he performed no experiments on animals or men. Pencillin was first used to treat humans by British scientists, Sir Howard Walter Florey and Ernest Boris Chain during the winter of 1940-41.

The first antibiotic to be used was tyrothricin (one of the purified forms of which was called granicidin) isolated from certain soil bacteria by the American bacteriologist Rene Jules Dubos in 1939. This substance is too toxic for general use, but it is used in the external treatment of certain infections. Other antibiotics produced by actinomycetes (filamentous and branching bacteria. which are present in soil, have proved more successful. One of these, streptomycin discovered in 1944 by the American microbiologist Selman Abrahar Waksman and his associates, is effective against many diseases, including tuberculosis, in which penicillin is quite useless. Since then, such antibiotics as chloramphenicol, tetracyclines, erythromycin, neomycin, nystatin, amphotericin, cephalosporins, and kenamycin have been developed. They are used in the treatment of infections caused by bacteria, fungi, viruses, rickettsia and other microorganisms.

In clinical treatment of infections the causative organism must be identified and the antibiotics to which it is sensitive must be determined. The method of determination may be defined briefly as culture sensitivity. Two or more antibiotics may be used simultaneously to treat an infection. They may be administered locally, orally or by injection into muscle, vein spinal fluid canal or certain body cavities.

Hazards resulting from improper use of antibiotics include the creation of bacterial strains resistant to the drugs and allergic reactions or other undesirable side-effects in patients. Appropriate care should be taken in antibiotic treatment of viral upper respiratory infections such as common cold and febrile illness in adults. Much research has been done on finding chemical modifications of antibiotics that are non-toxic, easily administered, readily controllable in their side-effects, and less likely to induce resistance in sensitive bacteria that had previously been vulnerable to antibiotics. In some instances, resistance to an antibiotic has been transferred from one class of bacteria to another. Oral penicillins, which are resistant to gastric juices and thus are able to pass into the blood stream without loss of activity, have been produced. They are known as semisynthetic penicillins.

Antibiotics have also been used in a variety of non-clinical ways. When added to an animal's feed, they foster growth, particularly in the number of offsprings in a litter.

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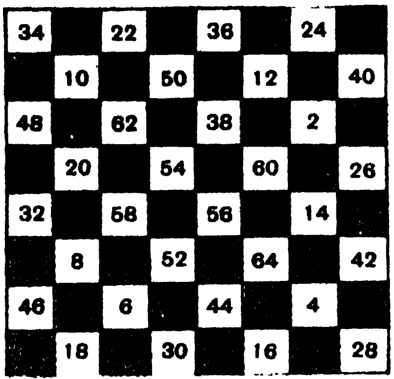
Chess-board problems

IN many books on recreational mathematics 'Chess-board problems' find a place. Such chess-board problems have a character which is by and large different from the game of chess. Occasionally, however, books on recreational mathematics may contain such chess problems as mate in a given number of moves (for example, Martin Gardner's *More Mathematical Puzzles and Diversions*). In some respects, such chess problems have a family likeness with mathematical problems. In the past chess-board problems have often interested such great mathematicians as L. Euler (1707-1783) of Switzerland and K. F. Gauss (1777-1855) of Germany.

The problem of knight's tour

One of the more interesting and much studied of the chess-board problems is that of 'Knight's Tour'. Here the problem is for one Knight to traverse all the 64 cells of a chess-board square without moving to any cell more than once in the process. The earliest mention giving hints towards a solution is due to two 18th centur mathematicians, De Moivre of England and De Montmort of France. They apply to a chess-board of 64 cells and consist of dividing (mentally) the board into an inner square containing 16 cells surrounded by an outer ring of cells two deep. If, initially, the Knight is placed on a cell in the outer ring, it moves round the ring always in the same direction, so as to fill-it-up completely, going into the inner square only when absolutely necessary. When the outer ring is filled up, the order of moves required to fill up the remaining cells presents little difficulty. If, initially, the Knight is placed on the inner square the process is reversed. The method is applicable to square or rectangular boards of all sizes. De Moivre's solution is illustrated below. Here '1' denotes the initial position of the Knight while 2, 3, 4..........., etc., the subsequent positions (Fig. 1).



34		22		36		24	
	10		50		12		40
48		62		38		2	
	20		54		60		26
32		58		56		14	
	8		52		64		42
46		6		44		4	
	18		30		16		28

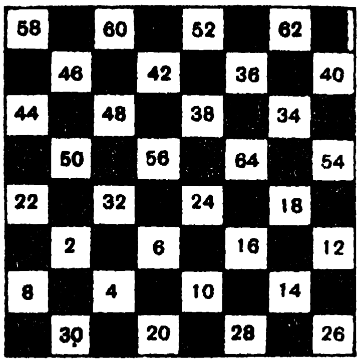
Fig. 1

The earliest attempt to deal analytically and systematically with the problems was made by Euler in 1759. He commenced by moving the Knight at random over the board until it had no move open to it. When carefully executed, this will leave only a few cells not traversed. Denote them by a, b, c........... Euler's method then consisted of establishing certain rules by which these vacant cells can be interpolated into various parts of the circuit and by which the circuit can be made re-entrant. The process is rather long and the reader is referred to W. R. Ball's *Mathematical Recreation and Essays*. The method is quite general and adaptable to solutions with imposition of additional restrictions.

Euler has given an interesting example in which the first 32 moves are confined to one half of the board. Two such solutions—one of them by Euler and the other by Roget—are reproduced (Fig. 2 and Fig. 3).

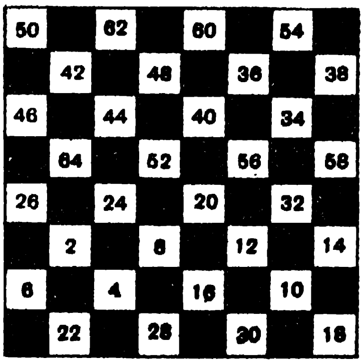
It may be noticed that moves 1, 2, 3, 4 and 33, 34, 35, 36 are identical in both the solutions.

A solution is reproduced here from Ball's book which has the property of 'magic squares'. (Squares whose entries in each row or each column add up to a constant num-



58		60		52		62	
	46		42		36		40
44		48		38		34	
	50		56		64		54
22		32		24		18	
	2		6		16		12
8		4		10		14	
	30		20		28		26

Fig. 2. Euler's half board solution

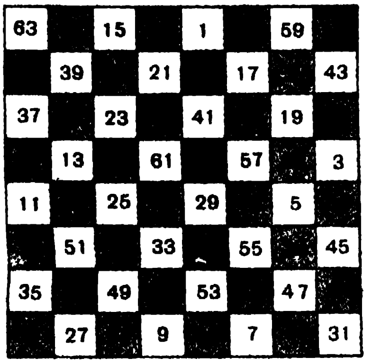


50		62		60		54	
	42		48		36		38
46		44		40		34	
	64		52		56		58
26		24		20		32	
	2		8		12		14
6		4		16		10	
	22		28		30		18

Fig. 3 Roget's half board solution

ber are called 'magic square'.) This is a 'closed tour' in the sense that from the 64th move one can again go to the starting point in one move. In the case where this is not possible the tour is designated as 'open tour' (Fig. 4).

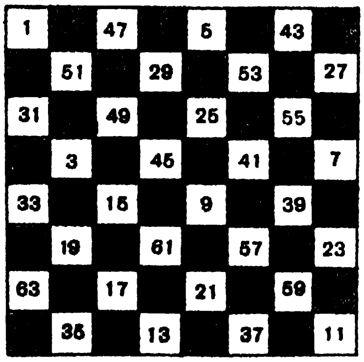
In October, 1967 issue of the *Scientific American*, Martin Gardner has given a very interesting case of an 'open tour' with magic square and other properties. This is reproduced in Fig. 5.



63		15		1		59	
	39		21		17		43
37		23		41		19	
	13		61		57		3
11		25		29		5	
	51		33		55		45
35		49		53		47	
	27		9		7		31

Fig. 4

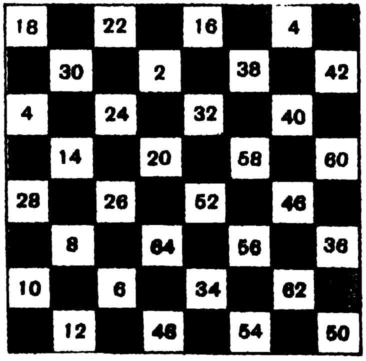
It will be noticed that in this solution each row or column adds upto 260 and each of 16 squares to 130. It will be noticed that this is an 'open tour'.



1		47		5		43	
	51		29		53		27
31		49		25		55	
	3		45		41		7
33		15		9		39	
	19		61		57		23
63		17		21		59	
	35		13		37		11

Fig. 5

In a book on the game of chess in Bengali language published more than 40 years ago, one solitary example of a 'closed tour' is given. This is reproduced in Fig. 6.



18		22		16		4	
	30		2		38		42
4		24		32		40	
	14		20		58		60
28		26		52		46	
	8		64		56		36
10		6		34		62	
	12		48		54		50

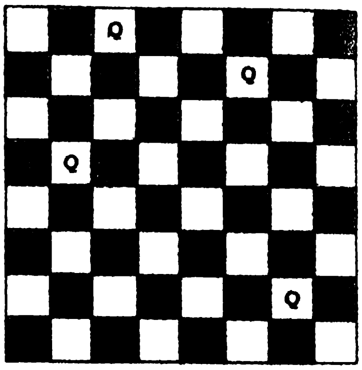
Fig. 6

Though it is not a half board solution it may be noticed that initially all the 32 squares on the left hand side as indicated with broad lines are covered. The remaining 32 squares are then covered in the 33rd to 64th moves.

It is not known whether the solution is derived from foreign sources, is an original one, or derived from Indian sources. In the above book, the solution in its original form is not indicated by numbers but by means of various Bengali letters written on the cells of the board with a somewhat odd rhyme which provides the sequence key to moves and the solution.

The problem of eight queens

In F. Schuh's *Master Book of Mathematical Recreations*, the "Problem of 8 Queens" finds a mention. Here the problem is to place 8 Queens on 8 × 8 chess-board such that none is attacking any other. This problem interested the great German mathematician K. F. Gauss. All the solutions were found by Nauck in 1850. One of the solutions is given in Schuh's book which is reproduced in Fig. 7; the position of the eight Queens is indicated by the letter Q. The solution looks easy.



		Q					
					Q		
	Q						
						Q	

Fig. 7

However, if the reader tries independently to get a solution, he will be forced to modify his view. Why not try?

PRASANTA CHOUDHURY

Science Quiz

Questions

1. After whose name was the medieval conception of the universe named?
2. Who was Tycho Brahe?
3. According to geologists, how old is the oldest evidence of the existence of organic material?

4. Who invented the "cloud-expansion chamber"? What for?
5. What is 'dihedral' in aeronautics?
6. What is analgesia?
7. Which stone formed by a volcano is used as an abrasive in homes?
8. Can clothes be washed by sound waves?
9. When nettles sting, a small quantity of which acid is injected into the skin?
10. What are the basic materials used for making (a) soap and (b) detergents?

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(W.B.)

(See answers on next page)

Do it at home

Foolproof burglar alarm

No doubt you have come across many circuits for burglar alarms. Well, try this one for simplicity. It uses no electronic parts such as transistors, resistors, etc. As this system operates on household current, it is economical. In case the burglar is clever enough to cut off your power supply before he attempts to enter, this device is one up on the burglar. It provides automatic battery takeover in the event of a power cut.

Consider Fig. 1. It consists of a transformer (T) and two relays (A and B). Relay A must have two contacts, i.e., 1 and 2. The relay B has only one, i.e., 3. The circuit has also a rectifier filter consisting of the diode (D) and capacitor (C). Besides it has an alarm (B) and a 9V battery to serve both as standby and source for the alarm. The alarm may be a 9V buzzer or bell.

The working of the device is simple. When power is on, the relay A pulls in the contactor. It closes contact 1 and if the trap (X) is intact, it completes the circuit and so the relay (B) becomes in parallel with the first. Thus both relays pull in the contactor and only contact 3 is open.

In case of a power failure, contact 1 is released and it springs back and closes contact 2. This again completes the circuit for the relay B, provided trap (X) is intact. The relay B keeps the contactor pulled in while power comes from the battery. Resumption of supply again keeps the circuit as before and the battery is cut off again.

If, however, in either case the trap is broken, circuit is left open causing relay B to spring back and close contact 3, which sets off the alarm.

About the trap or traps. All that is required is some conductor which can complete the circuit. For doors or other places you may use very thin (42 S. W. G.) copper wire which is difficult to detect especially in dark (Fig. 2).

For windows you may use an aluminium foil strip (Fig. 2.) You may use a number of traps but they must all be in series and then connected to X. Metallic door or window latches can also be properly used for the same purpose.

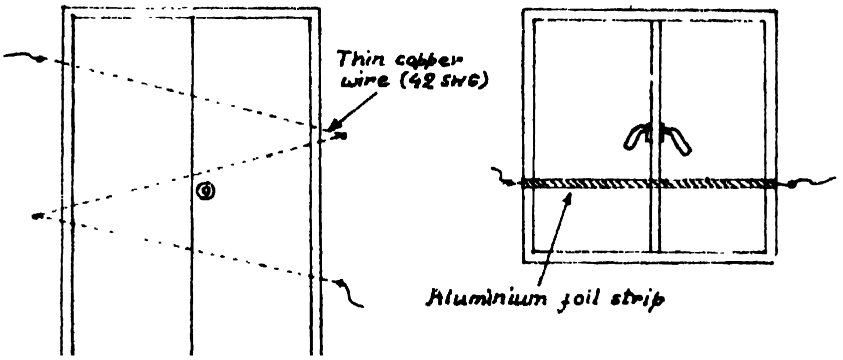

Fig. 2

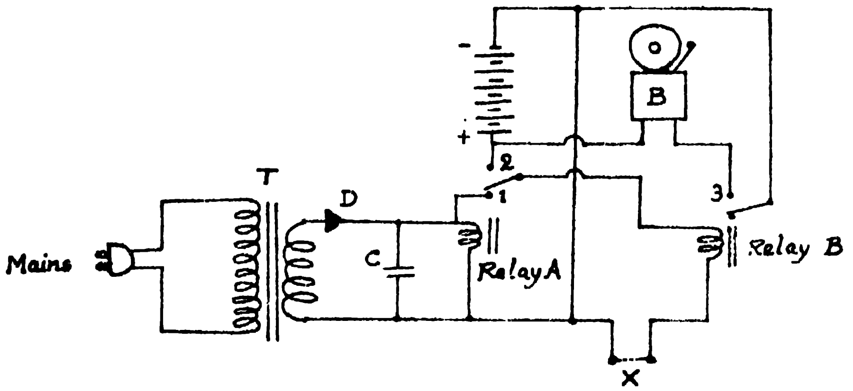

Fig. 1

Components

Transformer(T) = Detta B E 9 or equivalent
Diode (D) = BY 126 or equivalent
Capacitor (C) = 1000 μf 12V
Two Relays, Battery, Alarm, and Wires.

Shiladitya Mazumdar

Science Quiz

Answers

1. Ptolemy (The Ptolemaic System).
2. A sixteenth century Danish Astronomer. (He discovered Cassiopeia).
3. 1750 million years.
4. C.T.R. Wilson, Scottish Physicist Cavendish Laboratory, Cambridge to facilitate the study of cosmic rays.
5. The angle at which the wings of an aircraft are tilted (upwards downwards).
6. Local anaesthesia; the loss of the sense of pain without loss of consciousness.
7. Pumice stone.
8. Yes, by ultrasonics. When sound is vibrated through clothes and water, it causes water to move, which loosens particles of dirt in the fabric.
9. Formic Acid.
10. (a) Edible oils (olive, coconut, palm) and caustic soda or caustic potash.
    (b) By-products of petroleum coal tar.

PLASMA *(Continued from page 699)*

As deuterium is found abundantly in nature, the fusion reaction holds the promise of an inexhaustible supply of energy.

The fundamental problem of controlling such a fusion reaction is that of containing a high energy plasma long enough for an appreciable number of fusions to take place. This plasma confinement problem, however, still remains a challenge.

Nonetheless, a number of electronic and electrical devices make use of the plasma state. Among them are Thyratron, Ignatron, voltage regulator tube, transmit-receive radar tube, fluorescent tube, display-sign neon tubes and,of late, the laser tubes.

Plasma torches, the devices which convert electrical energy into heat, are being used for welding metals including stainless steel. Plasma torches have also brought with them a new concept in surgery—the bloodless surgery.

Plasma also holds great promise of providing an efficient alternative to inefficient steam cycle (thermonuclear energy in the form of heat, vapourizing water, driving steam turbines, generating electrical power) in the generation of electrical energy.

Further reading

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2. Uman, M. A. , *Introduction to Plasma Physics*, McGraw-Hill Book Company, New York (1964).
3. Tanenbaum, B. S., *Plasma Physics*, McGraw-Hill Book Company, New York (1967).

IRON OXIDE *(Continued from page 702)*

Further reading

1. Rama Sastry, V. V., Suryanarayana, A. Prasad, T. P. and Sant,B.R.; Iron oxide pigments: Part I—Methods of preparation of synthetic red iron oxide, *Journal of Scientific and Industrial Research*, Vol. 35, No. 3, p. 168.
2. Rama Sastry, V. V., Suryanarayana, A., Prasad, N.P. and Sant, B.R. Iron oxide pigments: Part II—Methods of preparation of synthetic yellow, black and brown iron oxides, *Journal of Scientific & Industrial Research* (in press).

NEWS & NOTES *(Continued from page 727)*

surfaces; concentrating systems;

(D) Space heating & cooling, including swimming pool, heating solar energy & architecture, solar thermal power systems: wind power:; and

(E) Agricultural & industrial applications including distillation. The post-Congress workshop and an exhibition of solar energy devices and products will also be held during that period.

For futher details, Dr. J. Gururaja, General Secretary, ISEC may be contacted at the Department of Science & Technology, Technology Bhawan,New Mehrauli Road, New Delhi-110029.

FOR HER

Vitamin E : What it can and cannot do

IN the early 1920s, two scientists at the University of California, H.M. Evans and K.S. Bishop, discovered a new vitamin that was necessary in rats' diets if they were to produce healthy offspring. The scientists named it 'tocopherol' which in Greek means "bringing forth in :hildbirth". In the vitamin alphabet, it became E. People still mistake vitamin E as a supplement to promote sexual performance or a remedy 'ertility problems. Some people take argedoses of vitamin E in the hope of 'uring or preventing heart disease and ı number of other disorders. Such 'iews are based on studies with aninals severely deficient in the vitamin, vhile E deficiency is extremely rare n man.

This vitamin is found in many 'ods, particularly vegetable oils, whole grains, fish, meat, dairy products, eggs, and green leafy vegetables. It is also used in food processing as an antioxidant to prevent rancidity. Furthermore, it can be stored in the body and is eliminated very slowly. In the only long-term study of vitamin E depletion in humans, adult men who were deprived of it for 3 years, showed no symptoms, even though their blood levels of vitamin E were very low. In fact, it is still not known with certainty what role vitamin E plays in human health. In the latest edition of the classic text *Human Nutrition and Dietetics* the puzzle is summed up as : "Vitamin E is one of those embarrassing vitamins that have been...handed to the medical profession with the suggestion that a use be found for it."

A number of possible roles have been suggested over the years, and still others are now under investigation. Severe vitamin E deficiencies in animals cause a variety of disorders, including a syndrome much like muscular dystrophy, bone, nerve, and heart-muscle abnormalities, a breakdown of red blood cells, sterility in males, and miscarriages in females. But the effectiveness of vitamin E supplements in treating these disorders in human beings have not been established. A number of studies over the last 35 years have shown that large doses of vitamin E appear to have no value in treating sexual or reproductive problems. So the two major questions about the role of vitamin E in human nutrition remain unanswered. What beneficial effect, if any, might be derived from large doses of the vitamin? And just what is its function in the body?

The only instances in which vitamin E supplements are known to be helpful are in three very special situations. Premature infants with hemolytic anemia benefit from vitamin E supplements. Such supplements are also recommended in infant formulas, because many babies, both premature and full-term, are born with comparatively low stores of the vitamin. Breast milk has enough vitamin E to meet their needs, but cows' milk may not have enough of it. The third use is for patients with deficiencies caused by problems of fat absorption. This includes people with such diseases as cirrhosis of liver, cystic fibrosis, obstructive jaundice, or persons who have undergone radical gastrointestinal surgery. It has also been suggested that vitaminE may supplement or protect against aging by hindering the oxidative processes in cells. But again, long-term tests with mice have shown that while those fed with vitamin E supplements have fewer aging pigments in their cells, they still grow old and die at the same rate as mice fed with normal amounts of the vitamin. Finally, there is a theory that vitamin E protects the lungs from oxidative damage from certain air pollutants. This has gained some support from studies which show that rats fed with generous amounts of vitamin E are less susceptible to lung damage than are rats with a vitamin E deficiency.

Eventually, it may be proved that vitamin E's chief function in the body is to protect other nutrients and body cells from premature degeneration. Meanwhile vitamin E remains a substance of mystery.

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Corrigendum

The legend to the figure on page 666 (*S.R.*, October 1977) should read "anticlockwise from top right" and not as printed.

Science in Industry

Rust converting composition

IT is a common practice to remove rust from steel structures before painting or repainting. Conventionally, rust is removed by mechanical or chemical methods which not only require shop facilities but also involve labour and time-consuming processes.

Keeping in view the drawbacks of conventional methods, the Central Electrochemical Research Institute, Karaikudi, has developed a rust converting composition which can be used to convert rust on steel surface into a protective coating. The surface so converted acts as a good base for painting and increases the paint life. The composition can be applied by brushing on erected steel structures.

The process for the manufacture of the composition consists of mixing phosphoric acid, manganese carbonate and acetic acid. A metal powder is added in suitable proportions to the above composition just before its application on rusted surface. The composition converts rust into a black, hard, protective coating in two hours.

The ingredients are to be mixed in proper proportions to get an effective rust converting composition which will give black protective coating on rusted surfaces. The shelf life is 8 hours after mixing.

The process has been studied on 90 litres per batch scale. All the raw materials used in the composition are indigenously available. No special equipment is required. Only tanks made of polythene are needed.

The suggested capacity for an economically viable unit is 150 tonnes of rust converter per annum. It is estimated that a sum of Rs. 3.03 lakh will be required to put up such a unit. The cost of production is estimated at Rs 7.50/kg.

Some useful plant products

SCIENTISTS in the national laboratories are ever exploring the country's plant wealth for useful products. Recently, some plant products have been obtained which can be used in pharmaceuticals and plastics industries.

The Regional Research Laboratory (RRL), Bhubaneswar, has developed an improved process for the extraction and separation of strychnine and brucine, the two important alkaloids of pharmaceutical importance. They are present in plant materials, particularly the seeds and bark of nux vomica, a Strychnos species tree.

The process has been studied on a laboratory scale. The essential items of plant and machinery required are also available indigenously. It is estimated that for the production of 1.90 tonnes of strychnine, 1.80 tonnes of brucine and 2.55 tonnes of mixed alkaloids per year, the total outlay required will be Rs. 4.50 lakh.

In another experiment, the Bhubaneswar Laboratory has developed a process for preparing grinding compounds from palm oil sludge as the raw material. This sludge is a waste material of tinning mills. Grinding compounds are used for grinding surfaces to desired fineness required for matching parts, valves, etc. They are also used for cutting paints, before polish, on metallic and non-metallic bodies. Palm oil grinding compounds are cheaper than petroleum grease-based grinding compounds at present in use in the country.

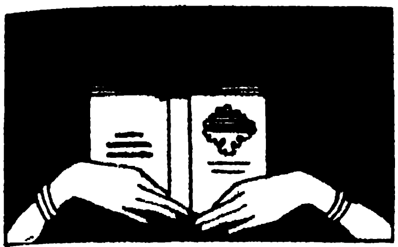
The process has been studied on a 5 kg scale. The total investment for putting up a unit with the suggested capacity to produce 10,500 tins of 100g and 6000 tins of 500g each of grinding and rubbing compounds per annum is estimated at Rs. 67,600.

Polyurethane polymers

The National Chemical Laboratory, Poona, has found that polyurethane foams used in many industrial applications can be obtained by using two indigenously available materials, shellac and cashewnut shell liquid.

Rigid polyurethane foams are used in domestic and industrial refrigeration, transportation, insulation, structural reinforcement, and substitute for wood in furniture industry. Raw materials are being imported at present.

The physical and chemical properties of the foams obtained from shellac and cashewnut shell liquid were comparable to those of polyurethane rigid foam samples of commerce. A laboratory-scale foam-making machine has also been designed and fabricated.



BOOK REVIEWS

EARTH, THE LIVING PLANET

by Michael J. Bradshaw, *Hodder & Stoughton*, Indian representative: *B.I. Publications*, 359, D.N. Road, Bombay-400001, pp. 302, Rs. 79.20.

GEOGRAPHY generally means description of the physical aspects of the earth. It describes the natural resources, climate and the location of the different regions of the earth. Of late, however, a new branch of science, called ecology or environmental science, has come into prominence. Man has been forced to take a hard look at his environment, because he found that it was not as healthy and beautiful as he had fancied it would be in the early days of the advancement of science and technology. It has become essential to take a fresh look at the earth to find out the balance between the resources available and the ever-increasing demand on them due to the progress of technology. Science and technology have proved to be a great ally of man but it is now being discovered that they are also tending to destroy the environment in which he lives. The increasing use of pesticides and the discharge of industrial and atomic effluents are polluting the earth. It is wrong to assume that the earth is an inexhaustible source of natural wealth. There is a limit to it and the new geography should point out the limitations of the earth's resources. It should also highlight how long the earth's resources will last and how environment can change if chemicals of all varieties are allowed to be used in an increasing degree.

The book by Michael Bradshaw is an interesting attempt on presenting the resources, climate and the surface environment on earth in a simple language and in coloured pictures. The book will be useful to geographers, environmentalists and all those who have any concern for beautifying this only living planet in the universe.

REFLECTIONS ON BIOCHEMISTRY

Edited by A. Kornberg, B. L. Horecker, L. Cornudella and J. Oro, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OBW, Pp. 465, $ 9.50.

THE volume under review is an outcome of the well-intentioned idea of the Universities of Barcelona, Madrid and Houston in collaboration with the Stanford University and the Roche Institute of Molecular Biology to sponsor a symposium to honour Severo Ochoa on his septadecennial birth anniversary. The present day biochemists are indebted to S. Ochoa as much as to H. A. Krebs, Otto Meyerhof, Fritz Lipman and a few others who founded modern biochemistry. The volume is a fitting testimonial to the versatility of this genius whose life is devoted to persistent and perseverant search into many a vexing problem in biochemistry.

The volume starts with biographical sketch of Ochoa written by Fransisco Grande and Carlos Asensio. Born on September 24, 1905, Ochoa began his scientific career in the late 1920s under the guidance of Otto Meyerhof, who in Ochoa's words 'contributed most towards my formation and was the most influential in directing my life's work.' The chapter includes summaries of Ochoa's work on intermediary metabolism, ribonucleic acid synthesis and studies on the genetic code.

The subsequent chapters largely revolve round carbohydrate and intermediary metabolism, biochemistry of lipid and cell wall synthesis, nucleic acid and protein synthesis and regulation. It is needless to mention that the account of the metabolic processes in various chapters is exhaustive and is made up-to-date by the authors who are all well established in their respective fields, ten of them being none less than Nobel Laureates!

The personal thoughts and experiences that have infiltrated involuntarily into most of the articles have made them more absorbing. Masayasu Nomura (Wisconsin), for instance, gives an account of how many disappointments he faced and with what courage, patience and perseverance he overcame them. He was guided by Jim Watson to distinguish 'good' science from 'bad' science, and always tried to avoid any sort of involvement or entanglement in the 'rat trace' of which Seymour Benzer was very critical. Arthur Kornberg's article (Stanford, California) "For the Love of Enzymes" is an exposition of 'flirtations, affairs, and fantasies' with many enzymes but 'married to DNA polymerase', his favourite for over 20 years. Having worked with so many enzymes, he observes that 'the notebook record an enzyme purification should withstand the scrutiny of an auditor or a bank examiner'.

E. Racker's (Ithaca, New York) enthusiastic pursuit of enzyme purification was marked by success probably because he was guided by the dictum 'Don't waste clean thoughts on dirty enzymes'. His motto for the future biochemists is equally sound: 'Don't entertain dirty thoughts about clean enzymes'. His is a "Pathway from Psychiatry to Cancer".

In "Bioenergenics: Past, Present and Future", E. C. Slater (Amsterdam, the Netherlands) has provided guidelines to all those who feel the concern for the dwindling energy resources in the world. Following an excellent account of the evolution of the concept of phosphorylation, Slater's hope that the efficiency of the natural solar energy trapping systems will be increased and enhanced seems to be a calculated one.

The most suitable tribute paid to the septuagenarian, Severo Ochoa appears to be by H. A. Krebs (Oxford, England), the author of the 'Citric Acid Cycle' and one of Ochoa's earliest acquaintances. Krebs, in his "Comments on the Productivity of the Scientists", observes that only a small number of those who start research "continue persistently with undiminished vigour... He (Ochoa) is one of those men of science who is continuing research after he has earned all honours and material benefits that may be expected".

In a twenty page article "Prebiological Chemistry and the Origin of Life", J. Oro has mentioned some of the more specific observations of organic molecules in the interstellar space and comets. He has presented some experimental evidences to demonstrate that most of the building blocks of nucleic acids and proteins, high energy phosphates as well as a few oligonucleotides and oligopeptides, can be synthesised in the absence of the enzymes under conditions presumed to have existed in the primitive earth.

The whole volume is a wonderful journey through the ups and downs in the history of biochemistry and the reader is bound to benefit after reading articles in this volume. But for a few mistakes, such as addition of a full stop (which is unnecessary) after *E. coli* in the middle of a sentence, *in vito* for *in vitro*, not citing a reference—Ashwell *et al.*—but referred to in the text (page 219), this volume is and will be of immense value to all the students of biochemistry, particularly the beginners.

Most of the articles act like a tonic, for they revive the spirit of challenge and perseverance in tackling any problem. A few more photographs here and there might have added to the worth of the volume.

D. CHIDVILASA SASTRI

GENETICS *by* John B. Jenkins, *Houghton Mifflin Company*, Boston, 1975, Pp. *xiv*+562, $ 14.95.

ALTHOUGH there are a large number of good books on this subject, the need was of a well written book which could take into account the recent excitements in modern genetic principles. John B. Jenkins of Swarthmore College, Pennsylvania, has fulfilled it.

The book under review contains in all twelve well and authoritatively written chapters. In Chapter 1, the Mendelian principles of inheritance have been discussed and then the chromosome theory of inheritance is developed to relate Mendelian "factors" (now genes) with chromosomes. Then a good diagrammatic account of meiosis and mitosis follows. In Chapter 2 the chromosome theory of inheritance is further developed and various proofs have been given. Gene mapping, about which most of the books fail to provide a clear idea, has been properly discussed with various diverse examples. Then the mechanism and the cytological basis of crossing over has been elaborated. Chapter 3 extends Mendelian principles to other areas and specifically discusses quantitative inheritance, environmental effects, gene-gene interaction, and cytoplasmic inheritance.

Chapters 4 and 5 explore variation in chromosome number and structure (the genetic mutations), along with the principles governing the flow of genetic material through populations. Chapter 6 introduces us to the intensely exciting and sometimes frustrating progression of ideas and developments which leads to the identification of nucleic acids (DNA and RNA) as the carriers of genetic information. In this chapter the exciting sequence of events that led James Watson and Francis Crick of the Cambridge University, Cambridge, to elucidate the structure of DNA has been discussed. Chapters 7 and 8 dealing with the genetics of bacteria and viruses, are conceptually similar to the first three chapters in that they concern the transmission of genetic information from one generation to the next. In Chapter 9, the exploration of gene function has been discussed.

Chapter 10 sets forth the events leading to the discovery that genes produce proteins and to an understanding of the actual process of protein assembly in living systems. Chapter 11 discusses the fascinating unravelling of the genetic code—how an alphabet with four letters (the four bases in DNA) translates into one with twenty (the twenty amino acids in protein), and how such a nucleic acid protein association could have evolved. Chapter 12 views the phenomenon of gene regulation by studying first the experiments pointing to differential gene activity and second the various factors that regulate gene activity.

The book gives clearly an overall and well balanced picture of the vast subject in the shortest possible space. Written in a very simple and lucid way and appropriately aided by good diagrams, the book may be of interest to students who wish to understand genetics. Though the price of the book is high, libraries can possess it.

SUBHASH S. ARORA

PROBABILITY AND STATISTICS

by A. M. Mathai and P. N. Rathie, *The Macmillan Co. of India Ltd.*, 2/10 Ansari Road, New Delhi-110002, 1977, Pp. 406, Rs. 48.00.

THIS book is a useful addition to literature on 'Probability and statistics'. The book requires little more knowledge than elementary calculus. It is, however, unlikely that a reader having only this much knowledge of calculus would possess the manipulative skills to understand the book.

The book has three main sections. Part one deals with the 'Basic statistical concepts'. It contains an excellent summary of 'Statistical populations and sampling', 'Outcome set' and 'Probability'.

The second section entitled "Probability models" covers more than a simple presentation of the continuous univariate and discrete univariate models. The authors have highlighted the 'Sampling distribution' and 'Stochastic variables' with many examples.

In the third section, foundation of 'Statistical inference' is discussed in detail. Chapters on 'Statistical estimation', 'Tests of statistical hypotheses', 'Some non-parametric tests', 'Statistical regression' and 'Analysis of variance' are presented in an impressive and simple manner. A large number of practical examples which occur in daily life are also given.

In short, the concepts presented by the authors in most of the chapters are properly defined with illustrated examples and counter examples. Also, all the important results, correspondence and relationships are given in tabular form for quick reference. This book is a well written source of basic information for mathematicians, statisticians and engineers dealing with probability and statistics. The book is also suitable as a textbook for a first course in statistics for arts, science, commerce and engineering students.

Although an excellent, well written introduction to the subject, the book is a disappointment in a few respects. For example, some of the concepts given in chapters 5 and 6 could have been discussed in little more details for the benefit of the students.

The price of the book is also prohibitively high—not in keeping with the pocket of an Indian student.

RAM NARAYAN

GRAVITATION AND RELATIVITY

by M. G. Bowler, *Pergamon Press* (as above) 1976, Pp. 172, $ 14.50.

THE book, which is Vol. 86 of the International Series in Natural Philosophy (General Editor: D. ter Haar), deals with some aspects of gravitational theory and relativity. The theory of general relativity, first proposed by Einstein, was ignored for quite a long time. The objection to the theory was that it was too complicated and its predictions could not be tested. However, the rapid development since 1960 in the experimental techniques led to the discoveries of compact X-ray sources, pulsars and neutron stars. They implied the presence of strong gravitational field which could be explained naturally within the frame work of general relativity. This revived interest in the general relativity which has now become an important theoretical tool in the study of astrophysics. This book is an attempt to bring out some of the features of general relativity without going into the complicated mathematical details. Starting from the Newtonian gravitational theory and Lorentz covariance, the author has made relativistic gravitational theory compatible with the experiment.

The book begins with brief introduction of special relativity. The gravitational red shift and deflection of light, within the frame work of Newtonian gravitational theory, have been discussed. After pointing out the failure of the theory, the author discusses in chapter 2 the consequences of the Eotvos-Dicke experiment, which establishes the equality of inertial and gravitation masses for most of the interactions (strong, weak and electromagnetic). In chapter 3, starting from the electrostatic and Lorentz, covariance laws of electrodynamics have been derived. The same reasoning with Newton gravitational theory and Lorentz covariance has been used in chapter 4 to obtain the three relativistic gravitational theories, viz., scalar, tensor and half tensor theories.

In chapter 5 variation of velocity of light, gravitational red shift and deflection of light in the gravitational field have been discussed within the framework of three theories developed in chapter 4. Chapter 6 deals with the distortion of the reference frame, whereas in chapter 7 author has discussed precession of the perihelion of the planets, in particular that of Mercury. The discussions in chapter 5, 6, 7 establish that only the tensor theory is able to explain the available experimental data. Chapter 8 elaborates upon the grvitational waves, their properties and the experimental verification. The gravitational theory in general curvilinear coordinates has been formulated in chapter 9. In this chapter one gets some idea of its mathematical complexities. Some of the results of chapter 5, 6 and 7 have been obtained from the general formulation. The last chapter deals with the black holes which are consequences of the strong gravitational fields.

The book has been well written and contains most of the information which would arouse the interest of a reader. The implications of the

(*Continued on page 729*)

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THE ATMOSPHERE OF MARS
TISSUE CULTURE, BREAKTHROUGH IN PLANT PROPAGATION
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LETTERS

New gel-filtration medium for macromolecules

Sir, We have been working on the development and utilisation of new products from guar seeds. Two successful, yet unconventional, uses of guar gum have been made (see *S.R.*, September 1977). Both these applications are based on the preparation of cross-linked, insoluble resins from guar gum. Such a resin, because of the presence of selective boron binding *cis*-glycol group in its molecule, has been used for separation, concentration and determination of boron in natural sources.

The other important application of the guar resin is as a gel filtration medium for macromolecules such as proteins, nucleic acids and polysaccharides. Gel filtration of macromolecules is based on the sieve action of the porous beads. The flow of the molecules which enter the pores of gel particles is retarded. The effectiveness of the gels is increased by introducing ionic groups. The results indicate that these resins behave just like Sephadex gels, and may prove cheap and indigenous substitutes for them. Currently Sephadex gels of different grades are available in India at Rs. 250 to Rs 450/100 g and their total import is worth a few lacs of rupees.

We have also synthesised ion-exchangers (similar to Sephadex ion-exchangers) based on guar resins. Persons working in the field of macromolecules may try these resins and compare them with the corresponding Sephadex products. 20 g-25 g samples of these resins can be obtained from us on request. We shall be glad to know the efficiency and limitations of the resins so that improvements can be made. The resins may also find application . in immobilization of enzymes, and for making affinity chromatographic material.

Utilisation of guar gum protein for human food is also engaging our attention. Guar gum analysis for amino acids has indicated that the germ protein is a rich source of lysine, and the general amino acid composition of the protein is comparable to soyabean protein. We are working on the preparation of texturised protein food from guar gum and welcome any correspondence relating to this subject.

This work is being done under joint collaboration of the departments of chemistry and botany and the Centre for Desert Studies, University of Jodhpur, Jodhpur (Raj).

K. C. GUPTA
N. K. MATHUR
Department of Chemistry
University of Jodhpur
Jodhpur-342001

Extraterrestrial life

Sir, In the article **The search for extraterrestrial life** (*S.R.*, August 1977), the authors have laid stress on the biological analysis of soil samples for detection of life. In this connection, it may be mentioned that by intercepting radio signals from outer space also we can infer the existence of extraterrestrial life.

In 1960 a project called Ozma, for detection of extraterrestrial civilisation, was conducted in the U.S.A. The 27-metre radio telescope at National Radio Astronomy Observatory was focussed on the stars Tau Ceti and Epsilon Eridani. These stars are strong contenders for possessing planetary systems. However, no signals of an artificial character could be received. According to Prof. Carl Sagan of NASA, there are as many as one million advanced civilisations in the Galaxy. Such a contact is expected to help us to understand our place in the universe.

S. K. GURTU
Defence Science Laboratory
Metcalfe House
Delhi-54

X-rays

Sir, In **X-rays : Discovery and application** (*S.R.*, July 1977), the author says that "a high vacuum is created inside the tube so that the pressure is about $1/10^{-6}$ the atmospheric pressure. The cathode is electrically heated and when very high energy cathode rays (electrons) strike the anode at great velocities, the anode starts emitting X-rays."

In almost all text books of physics, it is mentioned that X-rays are produced when cathode rays fall on a metal plate called anti-cathode, and not on anode, as the author states. Would you enlighten us on this apparent or real contradiction ?

S. S. DHAKTODE
10/129, D. N. Nagar II
Andheri West, Bombay-50

Essentially, X-rays are produced when fast electrons fall on any metal, whether it is an anode or not. The simple figure of an X-ray tube shown in the article is not wrong. However, to increase the life of the tube, the anode is often placed outside the path of electrons which are allowed to fall on an anti-cathode made of the metal to be investigated.

A. W. JOSHI
Deptt. of Physics
Meerut University
Meerut (U.P.)

Electron microscope

Sir, Thank you for the article **The electron microscope** (*S.R.*, May 1977). I would like to know the following:

1. What is the value of refractive index (*N*) of the medium in electron microscope?
2. What can be the maximum value of Sin α in the expression *N* Sin α?
3. What is the approximate cost of a modern electron microscope?

R. Chandra Shekar
B-77, Airport Colony
Madras-600027

1. Since the entire electron optical path in an electron microscope is under deep vacuum, the refractive index (*N*) would obviously be unity.
2. The Sine of an angle has values between zero and one, and therefore the maximum value of Sin α in the expression would be one. However, the objective lens of modern microscopes is designed in such a way that at the position of the specimen the value of Sin α is one.
3. A modern transmission electron microscope costs between Rs. 2 lakhs and Rs. 20 lakhs, depending upon the inherent capabilities of the model to provide specific information and its precision.

Table 1

Type	Cost range Rs.
Table models of low resolution, low performance (TEM) microscopes	2-5 lakhs
Medium performance (TEM) microscopes	5-10 lakhs
High resolution, high performance (TEM) research microscopes with special accessories	10-20 lakhs

A. K. Moharir
Asstt. Physicist, Nuclear Res. Lab.
IARI, New Delhi

Man's evolution

Sir, I wish to add following observations to **And so cometh man** by B. K. Behura (*S.R.*, September 1977).

The fossil material belonging to the genus *Ramapithecus*, the only hominid known from the Sivalik Hills of Indian subcontinent, was discovered by G. E. Lewis from east of Haritalyangar village in Bilaspur District of Himachal Pradesh and not from near Chandigarh as reported (p. 555). The Sivalik Hills near Chandigarh and Haritalyangar are separated by the shortest aerial distance of about 65 km. The palaeoprimatological evidences suggest that *Dryopithecus*—a well-known Miocene primate—served as a common stalk for *Ramapithecus* on one hand and *Gigantopithecus* on the other. The discovery of a nearly complete mandible of latter genus (identified as a new species, i.e., *Gigantopithecus bilaspurensis* by Prof. S. R. K. Chopra, Head of the Anthropology Department, Panjab University) in 1968 from the Sivalik rocks exposed further east of *Ramapithecus* locality in Himachal Pradesh should have been taken into account by the author. For, this find is likely to throw new light on the earlier stages of differentiation of man-like primates and hominids.

Had mammalian evolution leading to the appearance of man been discussed by Dr. Behura in the light of palaeoecological changes witnessed by the earth during Mio-Pliocene Epoch, the article would have been more beneficial to the readers. The paleopalynological and geological investigations strongly suggest that the palaeogeographic set-up, climatic conditions, variety of foods available to the organisms, etc., are some of the significant factors which had a bearing on the trend of mammalian, including primate, evolution in the past.

I. J. Suneja
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Phytoalexins

Sir, It was interesting to go through the short account **What are phytoalexins?** (*S.R.*, July 1977). But any organic chemist would be disappointed at the chemical structures of the few phytoalexins mentioned.

Divalent oxygen is shown as trivalent by writing O as part of the (heterocyclic?) ring with the double bonds. It is a serious mistake, since the ring of the given compounds is homocyclic and oxygen is part of a phenolic function or its methyl ether. This should be written outside the ring with a valency bond, the ring then will have the correct representation. Further, isocoumarin is wrongly represented without the double bonds. The side-chain of ipomeamarone is not correctly represented; one wonders if the long side-chain *C* has six valencies as shown. A reference to the *Proc. Royal Soc., London*, 1972, 181B, pp. 233-246 would be helpful.

I would like, for the benefit of *S. R.* readers, to refer to a new class of phytoalexins from grapevines, recently isolated and described as 'viniferins' which are stilbene derivatives and oligomeric.

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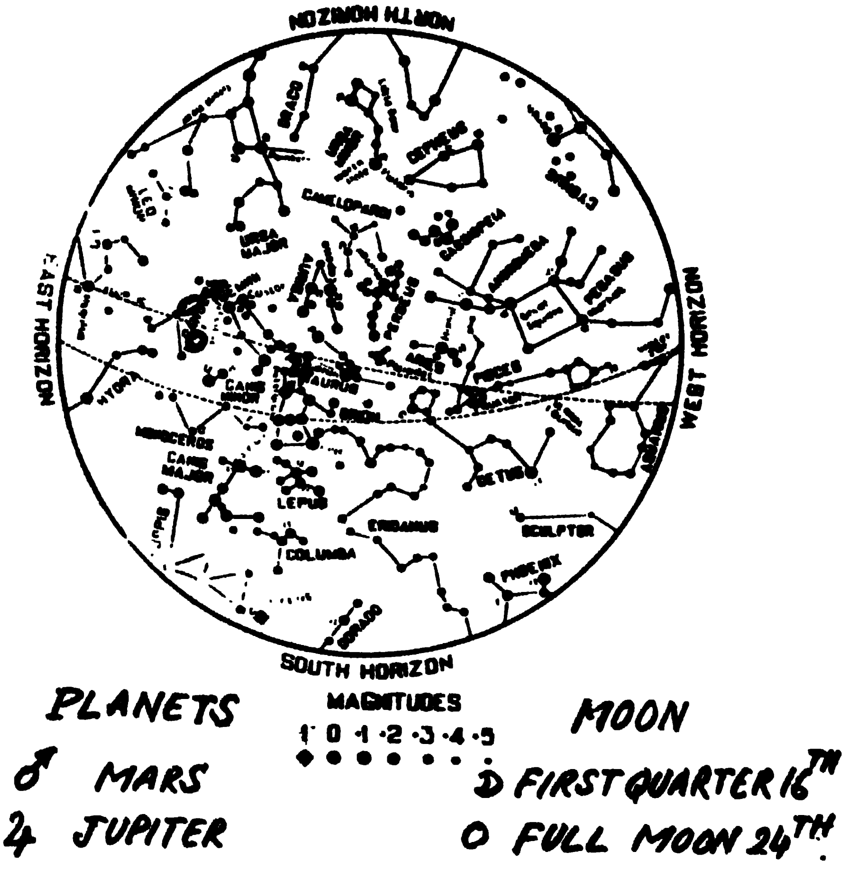
Planets and their positions

JANUARY 1978



The Moon

New moon occurs on 9th at 9-30 a.m. and full moon on 24th at 1 26 p.m. I.S.T. The moon passes about two and a half degrees north of Mercury on 7th, about five degrees south of Jupiter on 21st, nine degrees south of Mars on 24th and five degrees south of Saturn on 26th.

The lunar crescent becomes first visible after the new moon day in the evening of 10th. The moon is at perigee or nearest to the earth on 8th and at apogee or farthest from it on 21st.

The earth is at perihelion or nearest to the Sun on 2nd.

The Planets

Mercury (Budha), a morning star, rises about one and a half hours before sunrise during the month. It is at the greatest western elongation of about 23 degrees from the Sun on 11th. It moves from Scorpio (*Vrischika*) to Sagittarius (*Dhanus*). Its visual magnitude varies from +0.7 to —0.2.

Venus (Sukra) is too near the sun to be visible during the month. It is in superior conjunction with the sun on 22nd. It moves from Sagittarius (*Dhanus*) to Capricorn (*Makara*).

Mars (Mangala) rises at about sunset and sets at about sunrise. It is in opposition to the sun on 22nd. It is in Cancer (*Karkata*). Its visual magnitude is about —0.9.

Jupiter (Brihaspati) sets one and half hours before sunrise during the first half of the month and two and a half hours before it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about —2.3.

Saturn (Sani) rises about three hours after sunset during the first half of the month and about two hours after it during the second half. It passes one degree north of the Star Regulus (*Magha*) on 20th. It is in Leo (*Simha*). Its visual magnitude is about +0.5.

(Source: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st floor), New Alipore, Calcutta-700053).

Night sky during January, 1978

The diagram shows the brighter stars as seen from Delhi at 9.00 p.m., 8.00 p.m. and 7.00 p.m., I.S.T. on the 1st, 16th and 31st January, 1978 respectively. The portion in the diagram bounded by the dotted lines represents the Milky Way. The moon's symbols show the phases of first quarter and full moon. The bounding circle of the diagram represents the horizon with the directions as indicated. To use the chart it should be held overhead with the centre of the circle pointing towards the zenith and the diagram turned in such a way that the North, South, East and West directions marked on the chart point to the correct directions.

2. The star chart meant for a particular day for a given hour can be used for the next day 4 minutes *earlier* and for the previous day 4 minutes *later*. For example, if a chart is meant for 8.00 p.m. for the 16th January it can be used on the 17th at 7-56 p.m. and on the 15th at 8.04 p.m. In the same way it can be used for other months: for the 16th December it is for 10.00 p.m., for the 16th November it is for 12-00 midnight and so on.

3. To find the position of a star at any hour on a particular day from the star chart meant for that day, one can proceed as follows :—

First locate the star in question in the chart and determine the hour for which the chart is meant for that day, and then find how long after the above hour is the time for which the position of the star is required. This time differences in hours multiplied by 15° will be the shift of the star to the West from its position shown in the chart; it will however be towards the east if the given time is earlier than the time of the star chart. For instance the position of a particular star at 12.00 midnight on the 16th will be (12-8.00) × 15° or +°60 to the West of the position of the star as given in the chart for the 16th meant for 8.00 p.m.

N. SUBRAMANIAN
M. S. VENUGOPAL

What are Earthquakes ?

With better understanding of the causes of earthquakes, it is now possible to design safer quake-resistant buildings and even to predict when and where a quake would strike

EARTHQUAKE is perhaps the most insidious of the natural calamities that befall mankind. We cannot prevent it with a dam or by a powerful technology. The danger of an earthquake is enhanced manifold by fires, floods and landslides that follow in its wake. Statistics show that earthquakes take an average toll of 10,000 human lives a year (Table 1). In the recent earthquake of Tangshan city in China, about a million people are believed to have died. These figures could be considerably smaller if people could learn to predict earthquakes reliably. Unfortunately, it is difficult to predict earthquakes. Nobody, not even the cleverest of the scientists equipped with the most sophisticated hardware in experimental seismology, can tell when and where the next earthquake will occur.

As yet, there is no absolutely sure method of forecasting underground shocks. But we may look for an answer by comparing and analysing the diverse signs of the impending disaster. Understandably, the more such signs there are, the greater is the accuracy of the forecast. In this article, an attempt has been made to review the causes and prediction of earthquakes.

Earth

For studying the causes of earthquakes it is necessary to study the structure of the earth. The probable structure is shown in Fig. 1. The crust is solid and varies in thickness; under continents it may be about 40 km thick, but under the great mountain ranges the thickness may be about 60 km, under deep oceans the thickness is as little as 5-8 km. 30 km may be taken as the average thickness of the crust. At the base of the crust is the boundary known as the Mohorovicic discontinuity, or briefly, the 'Moho'.

Below the crust is a layer of rock known as mantle; the whole of it seems to be in a plastic or semi-plastic state. The outer core is liquid and may well be a high-pressure variation of ultra-basic rock. The inner core is solid and consists of iron, with some nickel and other denser materials.

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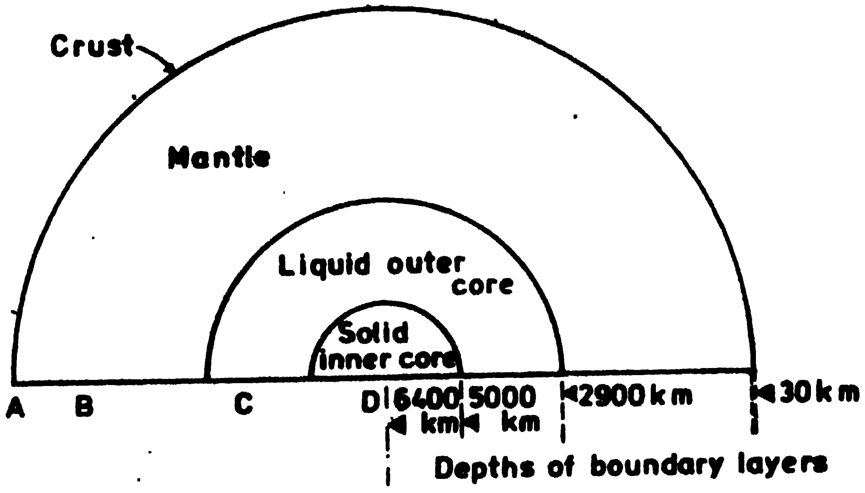

Fig. 1. Sketch of earth structure : (A) the crust, (B) various ultra-basic rocks, (C) liquid outer core, (D) the solid/metallic inner core

Causes of earthquakes

Earthquakes can be attributed to the following three main reasons:

1. Shrinkage of the earth's crust with cooling. This is not considered to be dominant;
2. Erosion and sedimentation. The estimated erosion of earth's surface is 100 mm in 3000 years over geological time. This rapidly accumulates and the pressure on mantle changes; and
3. Decomposition of radio-active material in the mantle. This generates heat, which is partly used up in causing plastic flow in the mantle and partly dissipated through the crust.

These factors combine to produce a state of strain in the mantle and crust. Where the stress reaches the breaking point there is fracture, and the strained rock rebounds under its own elastic stresses until the state of strain is wholly or partially relieved. Usually this fracture is along a fault plane and the movement may be horizontal, vertical or both.

"*This is all that is left of our Earthquake Control Research Laboratory.*"

The plane or line where the fault starts to move is called the 'focus' of earthquake; it is usually 5 km. to 110 km deep; on rare occasions it may be as much as 700 km deep. The point on the Earth's surface vertically above it is called the 'epicentre'. The shocks originating from 0 to 70 km depth are called shallow earthquakes. Those orginating from 70 to 300 km are called inter earthquakes; and from 300 to 700 km they are called deep earthquakes.

In recent years the theory of 'plate tectonics' has received widespread acceptance. According to this theory, the crust is composed of large 'plates' which move about the surface of earth; each plate consists of a landmass and its attached continental shelf. Originally all the landmasses were joined near the South Pole; later they broke up and moved apart.

Modern surveys of the Atlantic Ocean floor show that there is a slow welling up of the mantle along a line down the middle of the ocean. As a result, the American plate is moving away from the African plate. Also, a northward movement is observed in the African plate and the Indian plate. Where two plates meet, the only way in which there can be relative movement is that one plate slides over the other. This causes immense stresses. The release of these stresses causes sudden movement, called earthquakes. So an earthquake must be expected wherever there is a relative plate movement.

Many seismologists agree that there is a relation between earthquakes and the reservoirs created by dams, but they disagree on the kind of relation. Such a relationship was first noticed in the late 1930's when the level of earthquake activity near the Hoover dam in the United States seemed to correlate with the water level of Lake Mead created by the dam. Since then many theories have come up on the subject. According to David M. Evans of Colorado School of Mines (U.S.A.)

Table I

Place	Year	Lives lost
Shansi (China)	1556	830,000
Messina (Italy)	1908	100,000
Kansu (China)	1920	100,000
Kanto (Japan)	1923	100,000
Lisbon (Portugal)	1775	60,000
Quetta (Pakistan)	1935	30,000
Kangra (India)	1905	20,000

earthquakes may be caused by hydrostatic imbalances at depth. He suggested that the weight of water causes the quakes by placing extra stresses on the rock below. The hydrostatic pressure can also affect the timing of quakes. Another theory proposes that water seeping through the rock makes the reservoir more vulnerable to the stresses that cause earthquakes.

Earthwaves

The sudden rupture at the focus of an earthquake causes vibrations to move out in all directions in the form of waves. These waves start as simple periodic waves with different modes of propagation. The crust of the earth contains materials through which the waves move in different ways and get damped. The waves are reflected and refracted at the earth's surface and at junctions between different layers inside the earth. Many of them reach the surface of earth at or near the epicentre.

There are mainly three types of earthquake waves. Longitudinal waves, also known as primary or 'P' waves, are the fastest. They cause compression and expansion like sound waves. They travel at speeds varying from 5 km per second at the surface to a maximum of about 135 km per second at depths of 2900 km. Next comes the shear or secondary 'S' waves, which vibrate at right angles to the direction of travel like light waves, and cause shear. They travel at about two-thirds of the speed of 'P' waves. The 'P' waves travel through both solid and liquid parts of the earth, while 'S' waves can pass only through solid When these waves arrive at a boundary between layers, they may be refracted or reflected. Then either a 'P' or a 'S' wave may give rise to both 'P' and 'S' waves. The last to arrive are the surface waves, which are confined only to the crust and upper mantle. Surface waves travel through the crust at speeds from 2.5 to 4.5 km per second. They are mainly Rayleigh and Love waves (Fig. 2a). Rayleigh waves are characterized by a rolling type of ground motion in which the particles move in elliptical orbits in a plane normal to the surface, the sense of movement being opposite to the direction of wave propagation. Love waves are associated with a particle motion horizontal and normal to the direction of wave propagation.

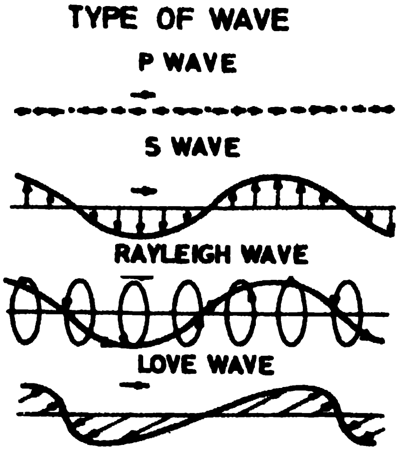

Fig. 2. (a) Propagational features of principal seismic waves .

The epicentre is the place on the earth's surface where the force of an earthquake is greatest, because it is the geographical point on the surface which is vertically above the focus (origin) of the earthquake Fig. 2. (b)

Magnitude and intensity

While studying earthquakes and their devastations, one comes across two very important parameters: magnitude and intensity. Magnitude is essentially a measure of the amount of energy released during the earthquake. It is calculated by finding out the ground movement at the observation point taking into account the depth of the focus and the epicentre distance. In 1935 C. F. Richter of the United States was the first to evolve a 10-point magnitude scale. Richter considered the magnitude of earthquakes in terms of the energy released. An approximate formula connecting energy in ergs and magnitude is

$$\text{Log}\,E = 11.4 + 1.5\,M$$

Where E is the energy in ergs and M is the magnitude on Richter scale. On this scale, the smallest perceptible shocks are near magnitude 2, and the largest recorded shock is about magnitude 8.9.

Intensity, on the other hand, is a measure of the physical damage caused by an earthquake and hence is maximum at the epicentre and decreases away from it.

When recording major earthquakes, a map showing the epicentre or epicentral area, surrounded by lines—called isoseisms—is drawn through places which record the same intensity of shock (Fig. 3). This helps in the classification of the seismic zones. The Roman numbers of the isoseisms given in Fig. 3 refer to the class in the modified Mercalli Scale.

"I told him I am a married man and have learnt to keep balance in the midst of temours. He gave me the job."

The first practical use of earthquake prediction came from a Chinese scientist, Jan Hen, during A. D. 78-139. He used a specially designed vessel to determine the location of the centre of the earthquakes. Inside the vessel was a pendulum connected to eight radial movable levers. At the end of each lever movable mechanisms were connected to dragon jaws each of which gripped a ball. (Fig 4) During a seismic impact, the lever corresponding to the direction of the impact was set in motion opening the mouth of the dragon, and the ball fell from the dragon's mouth into the mouth of a frog under it. With this sensitive instrument earthquakes could be detected even at great distances.

In U.S.S.R., single and multi-pendulum seismometers were used to predict the Tashkent earthquake of 26th April 1966. More recently, a group of scientists at the Stanford University School of Medicine in U. S. A. discovered that even chimpanzees can be used to predict earthquakes. These animals were found to become abnormally restless when tremors are on the way. They then spend more time on the ground than on their tree perches and nesting areas.

After many years of study, Moscow and Tashkent scientists have established that there is a close connection between seismic activity and certain changes in chemical composition of underground waters. They found that just before an earthquake the concentration of

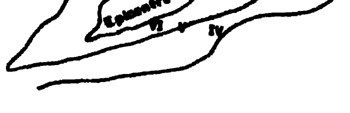

Fig. 3. magnitudes on modified Mercalli scale

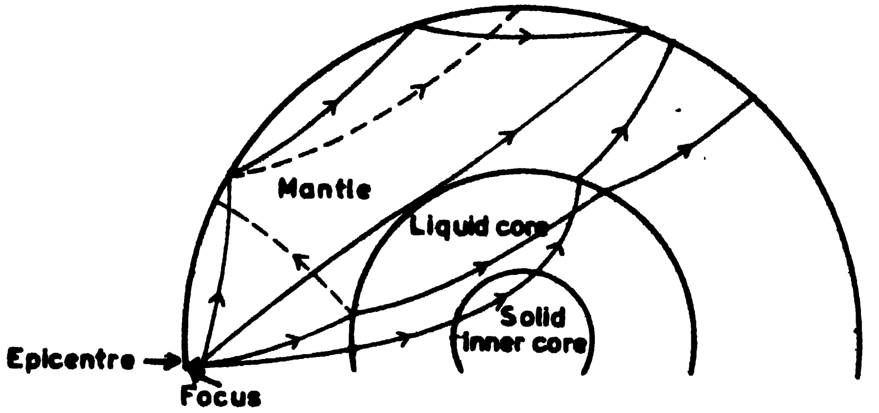

Fig. 2. (b) Focus, epicentre and paths of seismic waves

Forecasting earthquakes

MUCH of the loss of life in earthquakes could be prevented if it were possible to predict when and where a quake would strike. While absolute forecasting is not yet possible, good progress has been made in this direction by seismologists in the Soviet Union, United States and China. The methods of forecasting are based on observed changes in rock properties such as tilt, fluid pressure, electrical resistance, emmission or radon gas and changes in shock wave propagation velocities.

Much of the important early work on earthquake forecasting was done by the Russians. After a 20-year study following devastating Siberian earthquake of 1949, they discovered that prior to the onset of a shock, there is a sudden decrease in the ratio of velocities of seismic waves (Vp/Vs). Earthquakes occurred shortly after the ratio returned to normal.

Later work in the United States confirmed the Russian findings. Scientists at Columbia University's Lamont Doherty Geological Observatory found that the change in rock properties prior to a quake could be explained on the basis of 'dilatancy' or formation of cracks within the rock when it is under heavy strain. Rock strain and tilt could be monitored accurately using laser beams. Based on these studies, a few successful predictions were made about the place, time and even magnitude of impending quakes.

The world's first large-scale-earthquake warning system has been set up in China. It has 17 major observation centres which regularly receive data from 250 seismic stations, and 5000 observation points. In recent years, the Chinese system could successfully forecast at least two major earthquakes.

Some seismologists believe it may be possible in future not only to forecast but even to forestall quakes by artificially relieving rock strain before it reaches the breaking point. American scientists are experimenting with ways to control earthquakes by pumping out subsurface water, thus relieving pressure on rock formations that are under heavy stress.

B.B.

microelements rises noticeably in underground waters near the epicentre. It reaches its highest level during the shocks, after which the chemical composition gradually returns to normal. With this new method it is possible to predict an earthquake of 4 to 6 points on the Richter scale with a fair degree of accuracy.

Seismic research in India

In India, after the Assam (1897, 1950) and Bihar (1934) earthquakes, a great interest was created in earthquakes. The Indian Standard Code (IS 1893-1962) *Recommendations for Earthquake Resistant Design of Structures* was published in 1962. The Koyna earthquake took place in 1967 after the publication of this code. It is interesting to note that the Koyna region has been classified as earthquake-free zone in the earthquake map of India contained in the above publication.

The Koyna earthquake, which occurred in Koynanagar (400 km south of Bombay) with a magnitude of 7.5 on Richter scale, was considered a major earthquake. About 200 people lost their lives and many houses collapsed. Interest was revived in the study of earthquakes and earthquake resistant design of structures after this earthquake. The revised Indian Standard Code, *Criteria for Earthquake Resistant Design of Structures* (IS: 1893-1970) was published in October 1971. It contained the general principles and design criteria of buildings, elevated structures, bridges, dams, embankments and retaining walls.

The School of Research and Training in Earthquake Engineering, University of Roorkee, has conducted excellent studies on the Koyna earthquake and also on some of the recent earthquakes of Kinnaur (Jan. 19, 1975, Richter magnitude 6.8), Koyna (October 17, 1973, Richter magnitude 5.2), Shimoga (May 12, 1975, Richter magnitude 5.0) and Assam (July 8, 1975, Richter magnitude 6.7). Studies on earthquakes and earthquake resistant designs are also conducted by the Central Water and Power Research Station, India Meteorological Department, Geological Survey of India, National Geophysical Research Institute, Bhabha Atomic Research Centre and educational institutes like the Indian Institutes of Technology and Indian Institute of Science.

Computer programs for the design of earthquake-resistant structures are being developed at the Indian Institute of Technology, Madras. For an efficient earthquake resistant structure, ductile materials like steel is recommended. If other materials such as concrete are used, sufficient anchorages and connections should be made so that the structure acts as a single unit at the time of earthquake. The factors that affect earthquake damage are : (i) amplification

"My research papers on moonquake have been destroyed in this earthquake."

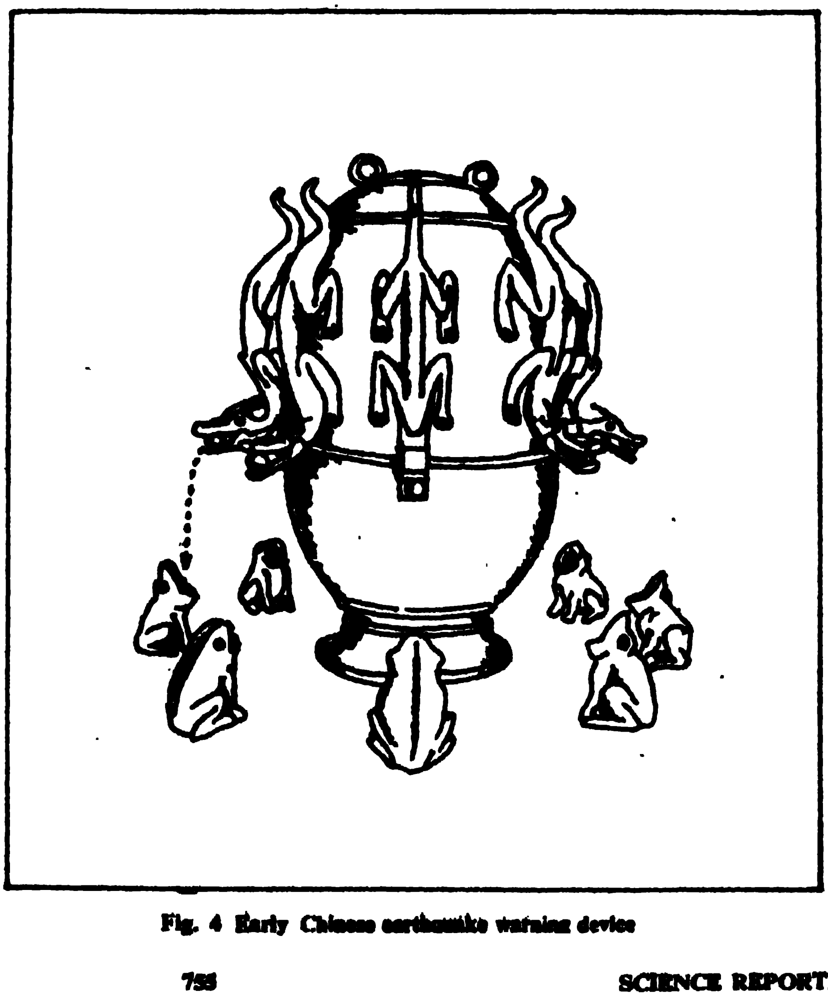

Fig. 4 Early Chinese earthquake warning device

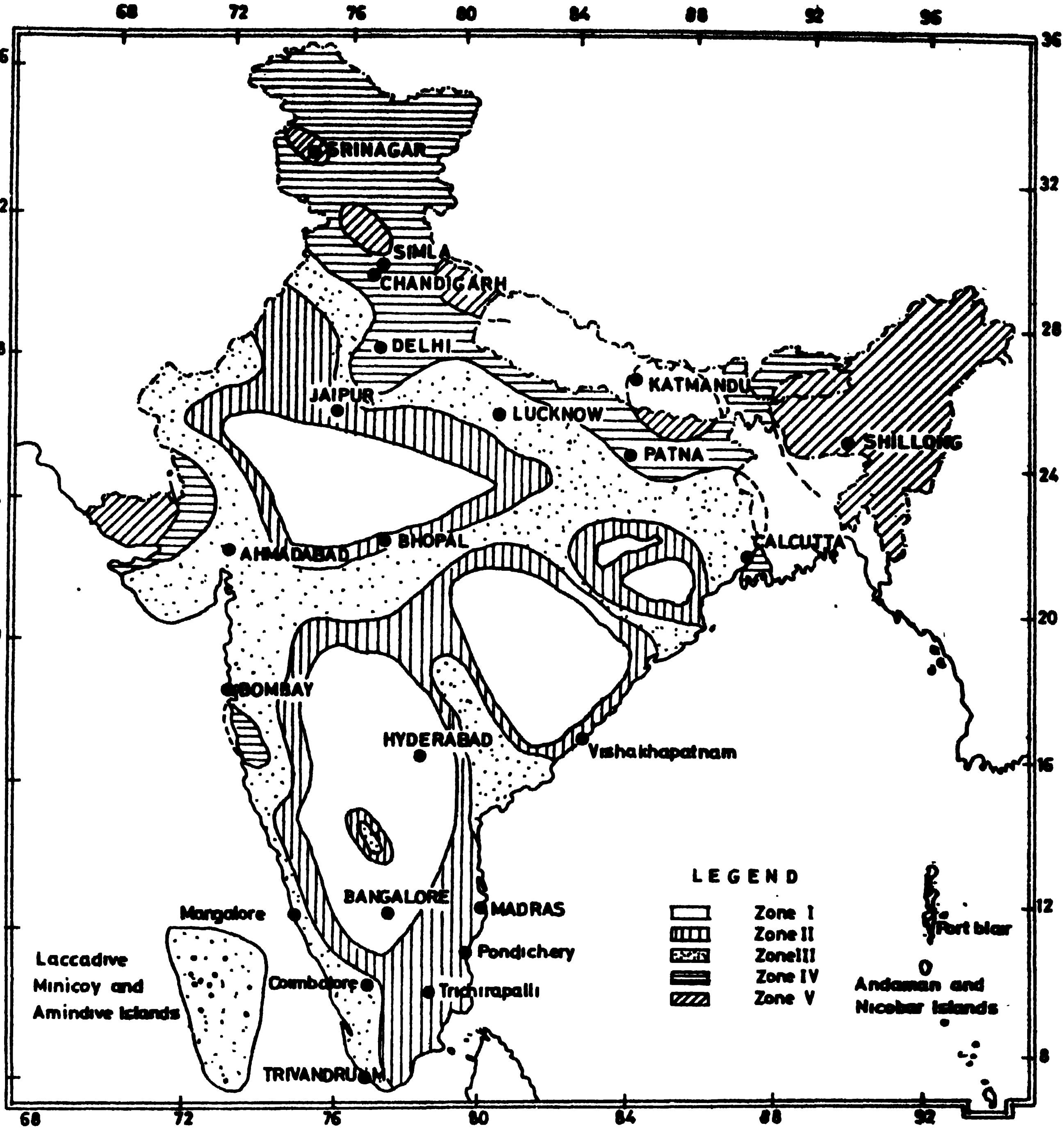

Fig. 4. Map of India showing seismic zones

of earthquake motion by soil layers; (ii) resonance of soils and structures, (iii) dissipation of vibrational energy; (iv) progressive failure; and (v) differential settlement.

In spite of the tremendous growth in research in earthquake engineering, there are a number of uncertainties about the various stages of design. The choice of ground motion and soil-structure interaction parameters pose a challenge to the designer. Since intuition and experience play a big part, the design worked out by two different groups could have considerable differences. Earthquake engineering design could be rightly termed as an art at present although no longer arbitrary.

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Seismic areas

THERE are two important belts where the earthquakes usually occur.

1. Mediterranean-Himalayas - South East to belt-2., and

2. Around the Pacific Ocean. New Zealand-East Indies-Japan-Aleutian Islands-West of Rocky Mountains—West of the Andes. A loop from this belt covers most of the West Indian Islands.

One more minor line of epicentres follows the valley of the great lakes in Africa.

Many earthquakes occur under the sea, and a shallow and severe shock cause 'seismic seawaves' or 'tsunami'. In deep water they may not be noticed by shipping, even if they are 1.5 m high, because their wavelength is several kilometers. However, in shallow water, their effect may be devastating. Generally, the sea recedes down the beach for some distance and then returns in a wave many meters high. The greatest tsunami on record occurred at Lopaka on the southern tip of Kamchatka peninsula in 1737 when the wave was 63 m high. Waves even 3 m high can do immense damage, and it is wise, when possible, not to site buildings in low land near the sea in risky areas.

For the purpose of determining the seismic forces, India has been classified into five zones (Fig. 4.) The seismic coefficients are also given in the Indian Standard Code (IS: 1893-1970), using which earthquake resistant structures could be designed.

N. S.
M. S. V.

FUNGI (*Continued from page* 775)

2. Persons affected with dermatomycoses should wash their clothes in boiling water (to kill the pathogen) and disinfect their shoes, socks and other articles with formalin.

3. One should not be careless about scratches and cuts on the skin. Antiseptic of proper concentration should be used to kill fungal spores and prevent infection.

4. Breathing in a dusty environment should be avoided to eliminate the possibility of bronchial and pulmonary infections.

5. Bathing or swimming in a rivulet or stagnant water should be avoided.

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THE INTELLECTUAL MACHINE

Pattern recognition machines have a number of potential applications

ASOKE K. TALUKDER

T. K. DAS

THE cover of a magazine displays a pretty young girl sitting in front of an enormous electronic computer. The advertisement is surely a bad one though. Of course, the girl has nothing to do with the whole business. It is neither the girl nor the machine that does the work. Problems are solved by mathematicians. Behind the solution of each problem handled by a computer is the genius of generations of great mathematicians, including present day scientists.

As for the electronic equipment itself, if the problem is merely to speed up the work of human calculators, there would be no need to devise computers capable of performing tens of thousands or millions of arithmetical operations per second Because such work could be done by much simpler and cheaper devices. What is really important is the possibility of solving qualitatively new problems. For example, it is almost impossible to compute manually, the trajectory of a spaceship in flight but an electronic computer can do that.

Readers may not think for a moment that the authors want to convince them that computers are unimportant. What we want to say is: Why do we use a computer for such jobs which could easily be done by human beings? A computer is a costly machine; why do we not use it for costly jobs? To do so, we have to use the intellect of a computer (if they really are intellectual).

Mathematicians have compiled programs for playing chequers, certain card games, and chess. There are computers that play fairly a good game. Machines nowadays are also programmed to prove theorems of elementary geometry. The hard core rationalist among the readers will, of course, ask who pays for all this recreation on the part of mathematicians. Let us remind the reader that the programming of a game like chess, or to prove theorems, is not done for fun, it represents a model of the intellectual activity of a human being.

At present, a good deal of attention is being paid to programs for translating one language into another, either by reading or hearing. It is still cheaper, of course, to hire a translator, but the time will probably come when machine translation will be cheaper. But, again, it is not a matter of money: machine translation is also a model of the intellectual activity of man.

Truly speaking, computers perform only arithmetical and elementary logical operations, enumeration

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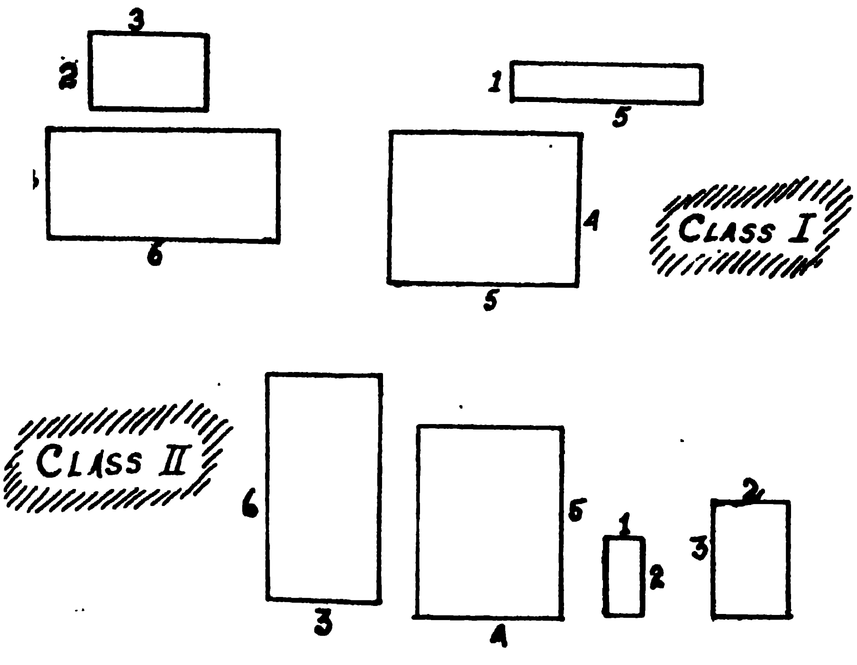

Fig. 1

operations, comparison of numbers and the operation of choice (say, choosing the largest number in a group of numbers).

Playing chess, composing music, solving equations and proving theorems can all be done by computers

"But for my association with you, Sir, I would not have got the compulsive urge to invent this electronic thinking brain."

in accordance with definite rules that specify the sequence of logical or arithmetical operations. These rules, that is, programming, are compiled by a human being.

As soon as a mosquito pierces the skin of a sleeping man, information goes to his central nervous system (brain) and is at once analysed. As a result his hands move to the mosquito either to kill or to brush it away. Can mathematical machines, like human beings and other living organisms, compile programs of actions by themselves for achieving specific aims as described above, or is it that without a detailed man-made programme they can do nothing? In this context, the word 'Machine' is understood to mean something made by human beings using hammer, wrench and soldering iron.

Today this question is being vigorously debated. Biologists, physicians and specialists in humanities are particularly active in defending the non-reproducibility of the living entity behaviour; i.e., the superiority of the living organism over machine. However, a machine can be taught to construct plausible arguments and in this respect it has overtaken its human teacher in a certain sense.

This is a complicated situation. But we will try to analyse it. The word 'Mama', 'Papa', 'Granny' are repeated, and fingers are pointed at them, and that is the way a baby learns. The mother all the time changes her appearance—different hair styles, different clothes—but she always remains Mama. The same applies to the father. Gradually the baby learns to distinguish other men besides his father. How are all these achieved? What is the process of learning and subsequent recognition of faces, cats, autos and so on? What is the mechanism like? We are not yet sure about anything in this direction.

How does a person distinguish a portrait of a woman from that of a man, birch leaves from oak leaves? It is not possible at present to teach a mathematical machine to separate a variety of objects into classes of similar objects, as we teach children to distinguish the letters of the alphabet written by different people (they are not exactly alike!). Or take clinical diagnosis when there are no two identical persons or two identical diseases. In this process no formalized criterion can be given to the machine for the classification of entities. We can only supply it with several objects of the classes, say, a dozen oak leaves and a dozen birch leaves.

The same problem arises when designing a machine for reading handwritten or typed texts, when compiling programs for a computer that classifies stages of schizophrenia or diagnoses cancer. Such an automatic machine, of course, models the thinking process in the human brain.

The first automatic devices for recognition of visual patterns were based on an analogy with the optic system of animals. The optic system is one of the most sophisticated and remarkable sensory organs, comprising roughly 130 million light sensitive cells (rods and cones). Beyond the layers of these receptors there are more layers of cells. They process incoming signals in a complex manner and send them on to the brain. There the signals are processed a number of times. The way light signals are treated by the visual analyser is still not clear to scientists, and the models set up to help us understand how this highly intricate apparatus operates have yielded only a very rough picture.

One of the pioneers in the modelling of the functions of thought by means of automatic devices was the American engineer F. Rosenblatt of Cornell University, U.S.A. He gave the name 'Perceptron' to automatic devices capable of modelling the functions of neurophysiological systems.

We will not dwell either on the theory of perceptrons or on the building of their models. The idea behind various perceptrons is very interesting; but, so far practical solutions of complicated problems have encountered considerable difficulties. For this reason many scientists engaged in the problem of modelling 'pattern recognition' have set out in other directions, one of which is described here.

Fig. 1 depicts rectangles of two classes. Can a machine be taught to classify such figures? Let us pose the problem more precisely. One is first shown only the eight rectangles depicted in the figure. Then a new rectangle is shown that does not coincide with any one of the 8 figures shown earlier. Is it possible to construct an algorithm (rule) for unambiguously placing the new rectangle in one of the two classes of figures?

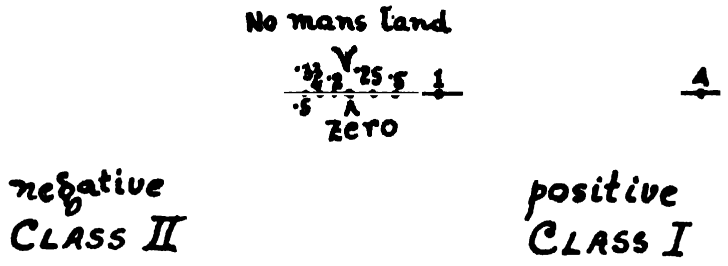

Fig. 2

The reader will at once say that it is very easy to formulate such a rule : horizontal and vertical rectangles. He is perhaps right; but how does one explain to a machine what, in fact, vertical and horizonal means.

That is not so difficult. We introduce the designation : x_1 for width of a rectangle and x_2 for the height. Then for rectangles of Class I and Class II, we have Table 1.

The important properties of such a classification algorithm may now be noted. First, the rectangles were separated into two categories. The rule to separate them was then enunciated. After the rule was chosen, the instruction period was over. Then new rectangles were submitted. Using the given rule, we classified the new rectangles by referring them to different classes, depending on whether corresponding

Table 1

Class	x_1	x_2	$x_1:x_2$	$(x_1:x_2)-1$	Class	x_1	x_2	$x_1:x_2$	$(x_1:x_2)-1$
I	3	2	1.5	.5	II	1	2	.5	−.5
	5	1	5	4		2	3	.67	−.33
	6	3	2	1		4	5	.8	−.2
	5	4	1.25	.25		3	6	.5	−.5

We now plot (X_1, X_2), where $X_1 = (x_2 : x_1) - 1$ for Class I and $X_2 = (x_1 : x_2) - 1$ for Class II. We see that the two-dimensional data sets are already reduced to one-dimensional ones and X_1 and X_2 are on a straight line where X_1 is always positive and X_2 always negative. In other words, if we take the origin as zero, the left side is Class II and the right side is Class I. Then there would be no scope for any problem in distinguishing between Class I and Class II (Fig. 2). Let us say the machine takes a ratio of x_1 to x_2 and then subtracts 1 from it. If the result is negative, the rectangle belongs to Class II and if positive it belongs to Class I.

"One sure test of your intellectual accomplishments is how much you are prepared to invest in itsmanufacture."

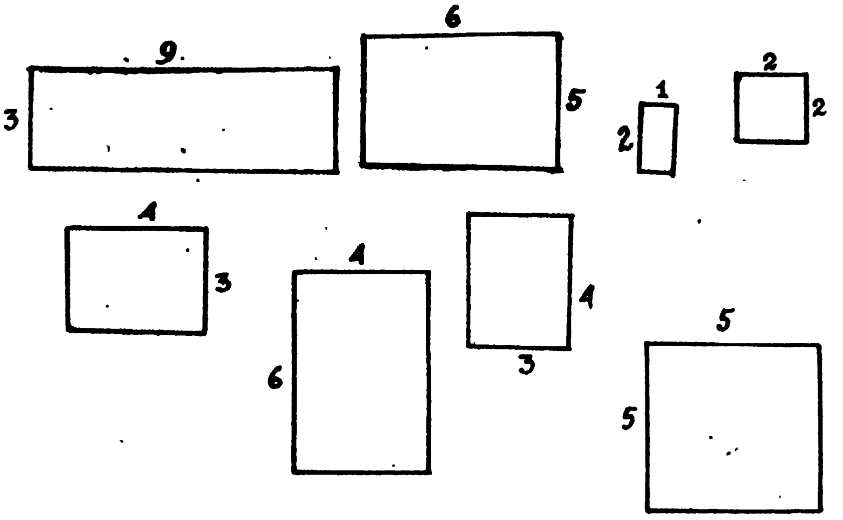

Fig. 3

points on the line appeared on one side or the other of the origin.

It is like an examination. Our assessment of the quality of the chosen rule depends on the results of the examination. Of course, we must know before hand to which of the two classes each of the new rectangles really belongs. The examiner always has to know the right answer. Then we can judge the quality of the chosen rule by the mistakes made at the examination.

Now let us discuss the results of the examinations. To verify the quality of the rule of classification used, eight rectangles shown in Fig. 3 were submitted. From the result, it is evident that rectangles (9, 3), (6, 5) and (4, 3) belong to Class I, (1, 2), (4, 6) and (3, 4) to Class II and the squares (2, 2) and (5,5) may be put in either class or in neither class, as both of them fall on the 'no man's land', i.e., the origin (Table 2). A machine can be taught to place the undecided class into Class III, where Class III represents squares.

In an easy problem like the one described above, we can divide the decision rule in three classes, but in real problems of pattern recognition the number of classes are quite large and so it is difficult to define the nature or even the distribution of the data set *a priori*.

Table 2

x_1	x_2	$x_1 : x_2$	$X = (x_1 : x_2) - 1$	Decision
9	3	3	2	Class I
6	5	1.2	.2	Class I
1	2	.5	−.5	Class II
2	2	1	0	Undecided
4	3	1.33	.33	Class I
4	6	.67	−.33	Class II
3	4	.75	−.25	Class II
5	5	1	0	Undecided

Today, to keep pace with the increasing amount of information that is to be processed, rapid formulation of newer pattern recognition methods is being developed. The worst thing that pattern recognition scientists often face is misclassification. So they are trying to have a tool that is efficient and at the same time gives cent per cent correct result. There is even a suggestion for the introduction of a new parameter called 'misclassification factor' which perhaps could decrease this havoc.

Pattern recognition machines have a number of potential applications. For example, they can be used in detection of crime and criminals, in estimation of natural resources etc. The pattern recognition scientists are even thinking of designing and making computers that can hear and understand, or machines that can speak and make us understand !

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BIOLOGY AND GEOMETRY OF THE CHAMBERED NAUTILUS

T. ANTONY DAVIS

The pearly nautilus attracts artists and biologists alike

ONE of the most acclaimed natural beauties is the shell of the chambered nautilus (*Nautillia* sp.). Painted, drawn, and photographed innumerable times, saluted in poetry, its graceful shape appeals to all viewers, even the artistically ungifted. There is an international science journal named *The Nautilus* founded in 1889 by Pilsbry, and the Delaware Museum of Natural History at Greenville (U.S.A.) is publishing a quarterly, *Chambered Nautilus Newsletter* which is now in its third year of publication. The remarkable nautilus lent its name to the deep-diving submarine in Jules Verne's adventure, *Twenty Thousand Leagues Under the Sea*. The air-tight chambers of the shell act as ballast tanks. Nautilus is also the name of one of the rafts used by the Indo-United States Ganga Expedition to navigate an unchartered gorge in the Ganges in 1976.

The great family of nautilus

Cephalopoda, to which the nautilus belongs, is a group of highly organised invertebrate animals of exclusively marine distribution constituting a class of the phylum Mollusca. They appeared late in the Cambrian, and with shells four metres long, they were the largest shelled invertebrates that ever lived. Some 3,500 different nautiloid species once flourished in the shallow seas that covered the prehistoric earth. The fossil of a long extinct species whose shell measured 2.7 metres was discovered in an Arkansas river-bed. About 130 genera and 650 species of living cephalopods are known of which octopus, squid, cuttle-fish and nautilus are the most familiar representatives. Cephalopods are characterised by a head with eight or more tentacles and highly developed eyes. The sexes are separate.

Now there exist only half a dozen species of nautilus; the main region of their survival is the Pacific Ocean from the Philippines to Fiji. They live in the sea as deep as 600 metres but ascend closer to the surface during nights. Although evolution has whittled these descendants to not more than 25 cm—only a small fraction of the size of their giant ancestors—their form has remained remarkably the same for ages.

Distribution

Nautilus is a popular name applied to two distinct genera of cephalopod molluscs—the pearly nautilus, also called the chambered nautilus, because of the many chambers in its shell, and the paper nautilus, *Argonauta*, a cosmopolitan genus of open ocean octopod.

Although the pearly nautilus lives mostly between the Philippines and

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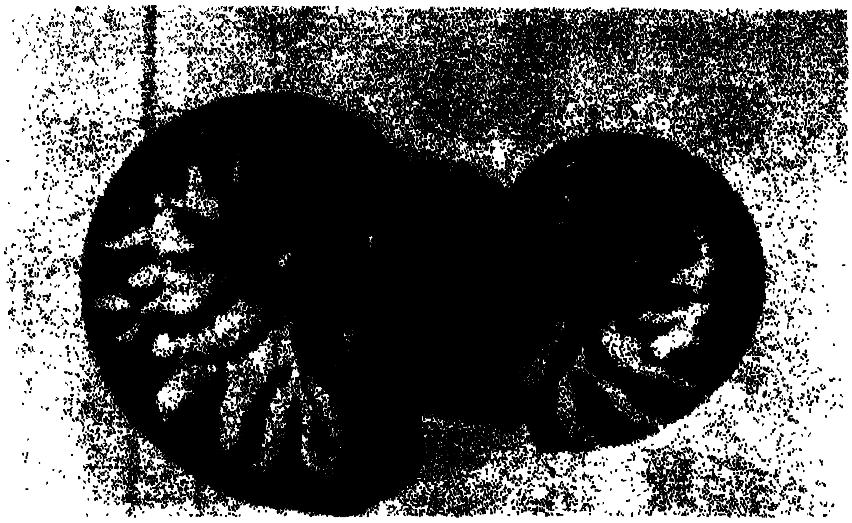


Fig. 1. Shells of baby nautilus. Note the prominent hole at the centre of the shell from where the coiling begins

Fiji Islands, dead shells are found on many beaches of the Indo-Pacific region. Traders in shell and shell products at Port Blair (Andaman Is.) flourish on the sale of nautilus shells which their agents collect locally. During our two expeditions to the uninhabited South Sentinel Island in 1973 and 1974, we collected a large number of nautilus shells, their sizes ranging from 2.5 cm to 22.5 cm (Figs. 1 and 2). The animal produces a series of ever-larger chambers, at an estimated rate of a new chamber every 2 or 3 weeks. The first four chambers of the shell are formed while the young nautilus is still within the egg. The mollusc fashions as many as 38 chambers, increasing in size with a mathematical consistency (*see cover*). The baby nautilus begins to coil its shell in such a manner that a hole, wide enough to insert a needle, is left at the centre (Fig. 1). But this hole gets covered later when more chambers are built with the secretion of pearly material (which the animal daubs on the shell in such a way that the central point of the shell is no longer visible). All the chambers are connected by a tube called siphuncle (Fig. 3) through which gases are released into or absorbed from the chambers as necessary. The shell thus acts as a float or hydrostatic organ that aids in ascending from sea bed to upper layers of water or descending to lower layers. When the nautilus swims, the largest (also the newest) chamber is the lowermost. The main food hunting region of this mollusc is the muddy ocean floor which abounds in small crabs, shrimps and shellfish, its main diet.

Unlike the octopus and the squid, the chambered nautilus has about 90 tentacles, most of them are small. They may be separated into three groups. Each eye has two tentacles, one in front and the other at the back. There is an outer ring of nineteen pairs of tentacles and an inner circle of many short tentacles around the mouth and beak. The first and third of these tentacles are said to be capable of being withdrawn into their sheaths. The tentacles of the nautilus are ridged to give them good grip on anything they hold, and they look different from the tentacles of octopuses and squids as they do not have any sucker. Some of the tentacles are extended while searching for food. As soon as they grasp a fish or a crab, they pass it to the ten tantacles near the mouth. It is now known that these appendages do not help the animal to crawl as was believed earlier. Two trailing tentacles support the nautilus while it tramples over the uneven surface of the ocean floor (Fig. 4). Locomotion is effected by jetting out of water through the funnel located below the layer of the tentacles (Fig. 3). When the animal has to move in a reverse direction, it aims its funnel forward and spurts off water. There is a prominent leathery hood with which the mouth of the shell is closed after drawing in the tentacles. The animal rests usually covering itself under the hood.

Use of nautilus shell

As mentioned earlier, the many-chambered spiral shell acts as ballast tanks and helps the nautilus ascend

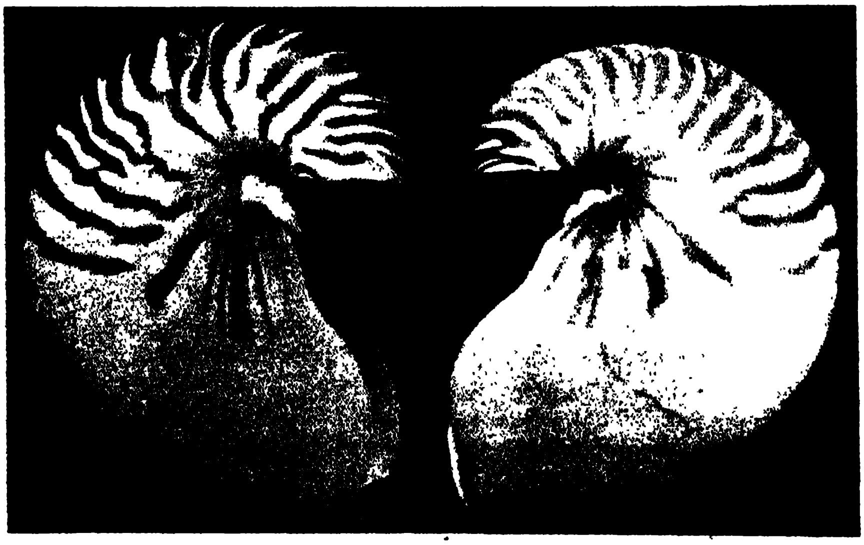


Fig. 2. Empty shells of two adult chambered nautilus. Flame markings on the shell are conspicuous on the older portion

or descend in the ocean. It offers, together with the hood, a good shelter for the resting animal. But perhaps the most important function the shell has is to protect the boneless, succulent animal from its predators. Judging from the injuries seen on many shells (one had upto 13 injury marks), it is clear that predators try to reach the prey by breaking the rim of the shell. But as the shell offers tough resistance to the smaller predators, the nautilus escapes from such attacks with minor injuries. The animal has even the capacity to repair and reshape the broken shell (Figs. 5 and 6). The animal daubs the shell in narrow strips with a special secretion of its body. These strips remain as permanent lines. When a bit of the broken shell is patched up with new material, the construction lines of the new surface do not match with the markings on the original shell as revealed in Figs. 5 and 6.

The shell, with its reddish brown flame markings on a white background, is a thing of beauty and consequently an object of commercial importance. When polished, it reveals its rare mother-of-pearl lustre. The shells are fashioned into lamps and other decorative items. They are also worked into cups, saucers, spoons, ear-rings, studs and bangles. In Polynesia and the Philippines, the shell is cut into fish lures.

Pioneer investigators

Although the shell of the nautilus has been known from the 16th century, the animal was not studied until 1831. The first animal ever studied was obtained from the New Hebrides in the South Pacific by George Bennett who gave it to his fellow student, Richard Owen, at the Royal College of Surgeons in London. Owen made a detailed anatomical study of the specimen and wrote a book on the results of his dissection. This brought him fame as the greatest anatomist of his time.

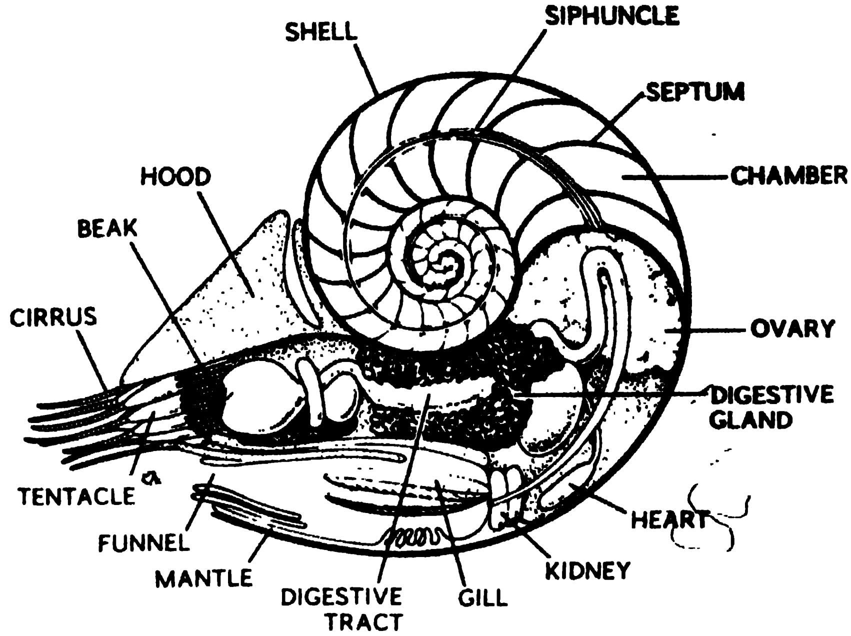


Fig. 3. A section through a live nautilus showing the important organs (*Courtesy*: *National Geographic Magazine*, **Washington**)

He died in 1892 as Sir Richard Owen. Among other early workers on nautilus, Anna Bidder of Cambridge University who went to New Hebrides to study the animal, E.J. Denton of the Plymouth Laboratory, J. B. Gilpui-Brown of the University of Auckland, are the more important ones. H. K. Dugdale publishes regularly the recent work on nautilus in his *Chambered Nautilus Newsletter*.

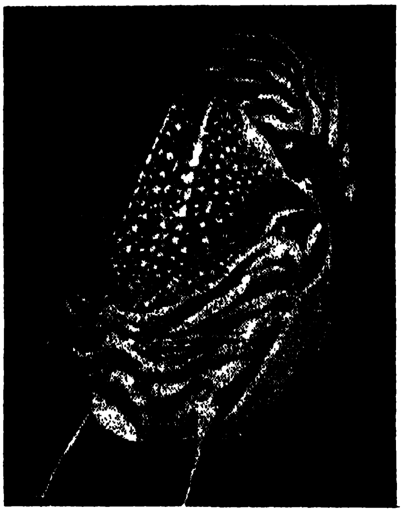
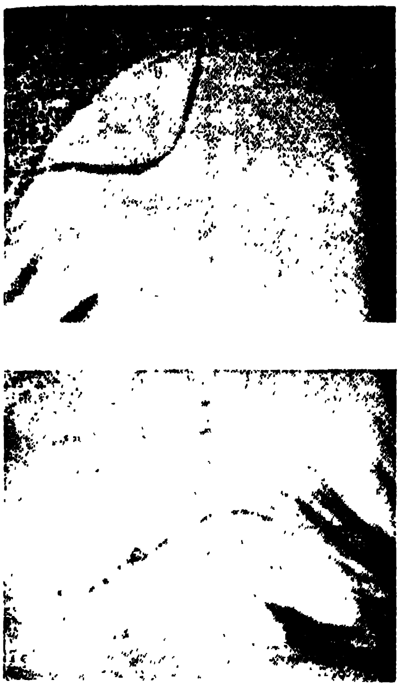


Fig. 4. Lone nautilus 'walking' with the help of two tentacles (*Courtesy* : *National Geographic Magazine*, **Washington, Black and white reproduction of a colour plate with permission**)

The paper nautilus

The paper nautilus (*Argonauta* sp.) is found in all tropical and subtropical seas, living near the surface. However, specimens of this nautilus have also been captured below 900 metres. It belongs to the eight-armed order octopoda, but differs from the octopods in having a thin unchambered, coiled shell, unlike either the internal shell of the squid or cuttlefish, or that of the chambered nautilus. The *Argonauta* shell is formed by large flaps or membranes found on the dorsal arms of the females (the males do not have shells). It is in this shell, cradled by the flaps, that the eggs are laid and the young hatch out. Large shells, which attain a diameter of 30 to 40 cm, are very fragile and highly prized by collectors. They are often found on the Florida coast in U.S.A. In contrast to the other octopods, the male of *Argonauta* is only about 1/20th the size of the female and possesses no shell. The male was once thought to be parasitic in the shell of the female. For many years the argonauts were pictured as sailing about the surface



Figs. 5, 6. Portions of shells of nautilus showing patched up injuries

of their seas with the arm flaps extended as sails, until the true function of het flaps was discovered. In all other essentials, the female resembles the octopus.

Incidentally, the word Argonaut is derived from the Greek *Argonautes* which means the sailor in the 'Argo'. According to a famous story in Greek mythology, it refers to legendary heroes who sailed with Jason in the Argo in search of the golden fleece.

The geometry of the nautilus shell

It is known that a rectangle of certain proportions has an appeal to a wider population than a rectangle of any other shape. Such a more appealing rectangle is known as the golden rectangle, e.g., *AFGD*, in Fig. 7. It is constructed in the following way. The side *AB* of a square *ABCD* is bisected at *E*. With center *E* and radius *EC*, an arc of a circle is drawn cutting *AB* produced in *F*. *FG* is drawn perpendicular to *AF* meeting *DC* produced in *G*. The resultant figure *AFGD* is said to be a golden rectangle with its charming and aesthetically pleasing appeal. The proof is also very simple. Let $AB=2$ units of length. Then $EC=EF=\sqrt{5}$ units. *AF* is divided by *B* in the golden section. *B* is also known as the 'golden cut'. It is associated with the idea of the 'mean proportional'. *AB* is the mean proportional of *AF* and *BF*. $AB/BF=AF/AB$, i.e. $AB^2=AF.BF$. From the golden rectangle, almost an unlimited number of squares, progressively decreasing in area, can be obtained as per procedure shown in Fig. 8. For the rectangle *ABCD*, $AB : BC = \phi = 1$. Through *E*, the golden cut of *AB*, *EF* is drawn perpendicular to *AB* cutting off from the rectangle the square *AEFD*. Then the remaining rectangle *EBCF* is a golden rectangle. If from this, the square *EBGH* is lopped off, the remaining figure *HGCF* is also a golden rectangle. This process can be repeated indefinitely until the limiting rectangle *O*, indistinguishable from a point, is reached. Such a figure offers the following interesting features :

1. The limiting point *O* may be called the *pole* of a unique spiral known as the equiangular spiral (logarithmic spiral) which passes through the golden cuts *D*, *E*, *G*, *J*,...The general equation of this spiral is r=ae cos a. The sides of the rectangle are nearly, but not wholly, tangential to the curve. This shows the connection between the logarithmic spiral and the golden section.

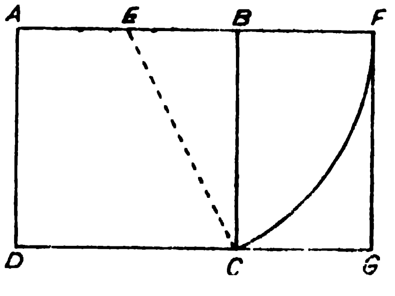


Fig. 7. Construction of a golden rectangle

2. Alternate golden cuts on the *rectangular* spiral *ABCFH*...lie on the diagonals *AC* and *BF*. This suggests a convenient method of constructing the figure.

3. The diagonals *AC* and *BF* are perpendicular to each other.

4. The points *E*, *O*, *J* are colinear, as also are the points *G*, *O*, *D*.

5. The four right-angles at *O* are bisected by *EJ* and *DG* so that these lines are mutually perpendicular.

6. $AO/OB=OB/OC=OC/OF=$ ... There is an infinite number of similar triangles, each being one half of a golden rectangle.

The relationship of the spiral to the Fibonacci series is evident from Fig. 8, for, the spiral is seen to pass through diagonally opposite corners of successive squares such as *DE*, *EG*, *GJ*,....... The lengths of the sides of these squares form a Fibonacci series. If the smallest square shown in Fig. 8 has a side of length d, the adjacent square also has sides of length d, the next square has sides of length 2d, the next 3d and so on, giving the series 1d, 1d, 2d, 3d, 5d, 8d,.... Therefore, it is very easy to draw the golden rectangle whose sides will have the measurements of two consecutive Fibonacci numbers. Say, in a rectangle if the length is 89 units and width 55 units, the rectangle is said to be a golden one. We can obtain from this figure, a continuous number of squares commencing with one having the side 55 units length, and others with units of lengths 34, 21, 13, 8,... etc.

Another interesting property of this charming spiral becomes obvious. However different two segments of the curve may be in size, they are not different in shape. Suppose a photograph were taken with the aid of a microscope of the convolutions near the pole *O*, too small to be visible by the unaided eye. If such a copy were suitably enlarged, it could be made to fit exactly on a spiral of the size of Fig. 8. The spiral is without

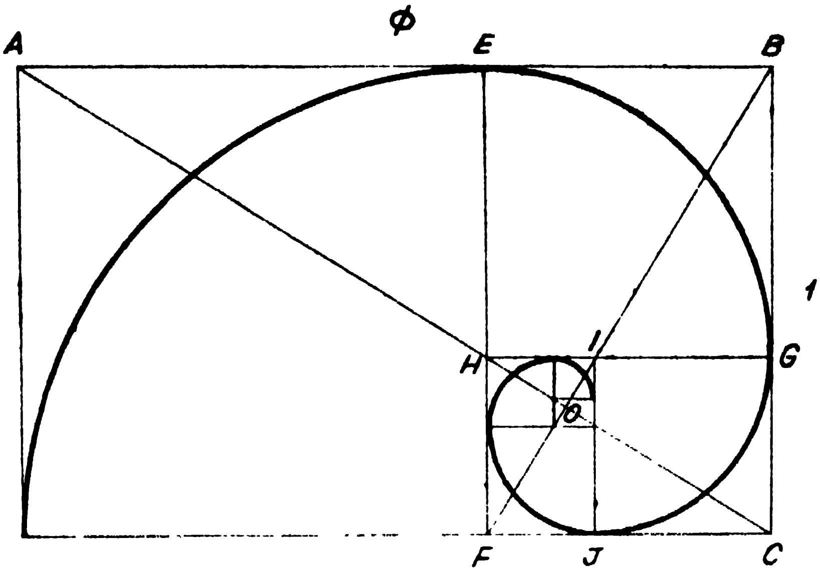


Fig. 8. Producing an equiangular spiral

a terminal point. That is, it may grow outwards (or inwards) indefinitely, but its shape always remains unchanged.

This is one of the examples of the Fibonacci series in nature. The successive chambers of the nautilus, as we have already seen, are built on a framework of a logarithmic or equiangular spiral. As the shell grows, the size of the chambers increases but their shape remains unchanged.

Equiangular spiral

A spiral may be defined as a curve which, starting from a point of origin, continually diminishes in curvature as it recedes from that point. In other words, its *radius of curvature* continuously increases. After a stage, the diminishing curvature tends to turn up in a straight line. Such a curve, of course, excludes the simple screw or the cylindrical helix, which neither starts from a definite origin nor changes its curvature as it proceeds. But true spirals are noticed in the horns of mammals, shells of molluscs, in the florets of a sunflower head, in the outline of a cordiform leaf, in the coil of an elephant's tusk and the like. Two important spirals of relevance for the present are the equable spiral (spiral of Archimedes), and the equiangular spiral (logarithmic spiral). Spiral of Archimedes appears when a rope of uniform thickness is coiled tightly on a horizontal surface. In this spiral, each whorl is of the same breadth as that preceding it and that which follows it.

In contrast to the spiral of Archimedes, in the equiangular spiral of the nautilus the whorls continuously increase in breadth, and do so in a steady and unchanging ratio. D'Arcy Thompson, the author of the classic, *On Growth and Form*, defines such a spiral as follows: 'If instead of travelling with a uniform velocity, our point moves along the radius vector with a velocity increasing as its distance from the pole, then the path described is called an equiangular spiral'. Each whorl which the radius vector intersects will be broader than its predecessor in a definite ratio. The radius vector will increase in length in geometric progression as it sweeps through successive equal angles, and the equation to the spiral will be r=ae.

The equiangular spiral was first recognised and designated so by the French philosopher Descartes in **1938 because the angles at which a radius vector cuts the curve at any point is constant. Mathematician Halley, noting that the lengths of the segments cut off from a fixed radius by successive turns of the curve were in continued proportion, named it the proportional spiral. Jakob Bernoulli (1654-1705) called it the logarithmic spiral.**

The fundamental mathematical property of the equiangular spiral corresponds precisely to the biological principles that govern the growth of the mollusc's shell. This is the simplest principle possible. That is, the size increases but the shape remains unaltered. The mollusc's shell grows longer and wider to accommodate the growing animal, but the shell remains always similar to itself. It grows at one end only, each increment of length being balanced by a proportional increase of radius so that its form is unchanged. The shell grows by accretion of material which it accumulates rather than due to biological growth. The only mathematical curve to follow this pattern of growth is the logarithmic spiral.

Logarithmic spiral and golden triangle

A golden triangle may be easily reached after a brief look at what is called a *gnomon*. A gnomon is a portion of a figure which has been added to another figure so that the whole is

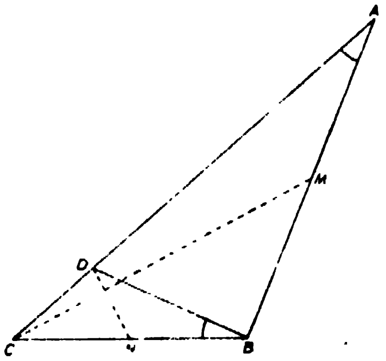


Fig. 9. Gnomons

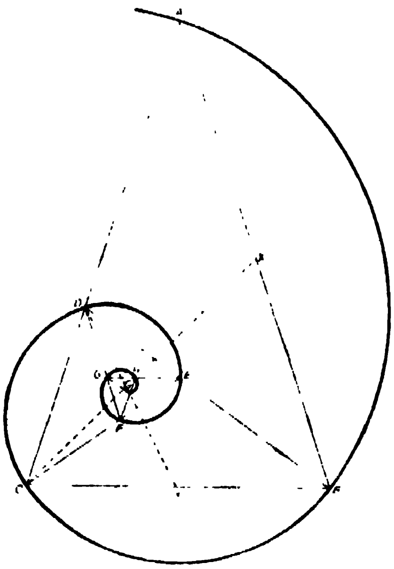


Fig. 10. Golden triangles and logarithmic spiral

of the same shape as the small figure (Fig. 9). Mathematicians have shown that in any triangle *ABC*, triangle *ABD* is a gnomon to triangle *BCD*, if angle *CBD* = angle A. If we add to or subtract from this triangle a series of gnomons, it turns out that all the apices lie upon an equiangular spiral. Radial growth (dr) and intrinsic growth in the direction of the curve (ds) bear a constant ratio to each other : $dr/ds = \cos a = \text{constant}$. The equiangular spiral is the only curve to possess this property.

An application of the gnomon principle which interested the contemporaries of Pythagoras concerns the isosceles triangle *ABC* (Fig. 11) which has base angles 72° and apex angle 36°. Here $AB : BC = \phi/1$. Hence the triangles of this figure may be termed 'golden triangles'. The bisector of angle *B* meets *AC* in *D*, so that *D* is the golden cut of *AC*. By this the triangle *ABC* has been divided into two isosceles triangles both of which could be called 'golden', their apex angles being 36° and 108°, and the ratio of their areas $\phi = 1$. Bisecting angle *C*, we obtain *E*, the golden cut of *BD*, and two more golden triangles. This process, producing a series of gnomons, converges to a limiting point *O*, which is the pole of a logarithmic spiral passing successively and in the same order through the three vertices of each of the series of triangles, *A*, *B*, *C*, *D*, *E*,.. . . . .

Aesthetic appeal

H.E. Huntley, author of the fascinating book, *The Divine Proportion*, quotes the opinion of marine biologists, artists, poets, psychologists and above all, mathematicians, on how they regard the beauty of the smooth curvature of the shell of the chambered nautilus. Poet Oliver Wendell Holmes wrote the following poem, entitled *The Chambered Nautilus*:

This is the ship of pearl, which, poets
  feign,
Sails the unshadowed main—
The venturous bark that flings
On the sweet summer wind its
  purpled wings
In gulfs enchanted, where the siren
  sings,
And coral reefs lie bare,
Where the cold sea-maids rise to
  sun their streaming hair.

The poet goes on to draw a moral in his last stanza on the life-history of the mollusc.

Build thee more stately mansions,
  O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than
  the last,
Shut thee from heaven with a dome
  more vast
Till thou at last are free,
Leaving thine outgrown shell by life's
  unresting sea.

The pearly nautilus attracts the artist both by the tints of its lustrous exterior and by the perfection of its spiral curve. Aesthetic appreciation of any sort has a dual aspect. Beauty evokes an immediate sensuous pleasure which is a common human experience. The sensuous satisfaction which is produced by simple lines has been studied by psychologists. Results of some of Lundholm's experiments summarised by H. E. Huntley are reproduced below :

Expressiveness of lines. When asked to draw a beautiful line, Lundholm's (1921) subjects tried to make one that was smooth, curved, symmetrical, continuous with rhythm or repetition and expressive of a single idea. For an ugly line they drew an unorganised mass without continuity, with mixed angles and curves and unrelated spaces ..., and when they wished to express merrment, playfulness, agitation or fury, they drew sharp waves of zigzags.

The subjects said : 'Small waves make the movement of a line go more quickly. The calm line has long slow curves.'

The long slow curve of the equiangular spiral, according to the above, must be evocative of calm feelings which may be regarded as a part fo the mathematicians' aesthetic experience.

Mathematician Jakob Bernoulli was so fascinated by the beauty of the logarithmic curve that he asked that it might be engraved on his tombstone!

P. N. UNNI & R. SREEKUMAR

TISSUE CULTURE: Prospects and Perspectives

Plant tissue culture has a great potential in crop improvement programmes

THE term 'tissue culture' is used in a broad sense to describe the growth of isolated embryos, plant organs, tissues or cells *in vitro* under aseptic conditions (in the absence of contaminating micro-organisms). The main types of aseptic cultures are plant culture (culture of seedlings or larger plants), embryo culture (culture of isolated embryos), organ culture (culture of isolated plant organs such as root tips, stem tips, leaf tips, flowers, etc.), tissue or callus culture (culture of tissues produced by proliferation from cut segments of plant organs), cell or tissue suspension culture (culture of suspensions of single cells or smaller cell aggregates dispersed in liquid media) and protoplast culture (culture of mechanically or enzymatically isolated protoplasts). The technique of tissue culture has advanced much in recent years, particularly the development of more refined methods, culture media, etc. E.C. Cocking, of Department of Botany, University of Nottingham, U. K. (*Nature*, 187 : 1960) has demonstrated even the possibility of isolation of naked protoplasts by dissolving cell wall with enzymes. This has opened up the possibility of fusing plant protoplasts of different species to produce hybrid cells. Recently developed techniques enable protoplasts, during their isolation by cell wall dissolution, to take up nuclei or other cell organelles. They do it by enclosing the organelles in a vesicle of plasma membrane just as an amoeba feeds on its prey. Later, the ingested 'foreign' structures may release their DNA in the cells in an active form, which get incorporated into the genome. The property of naked protoplasts to get fused spontaneously in culture makes somatic hybridization (parasexual hybridization) in plants possible, using either diploid or haploid protoplasts. This technique of tissue culture has also opened up new vistas in mutation breeding and offers the possibility of rapid eco-

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nomic isolation of specific mutant types of agricultural utility.

Parasexual hybridization

Parasexual hybridization, a recent development in tissue culture technique where the cells of two sexually incompatible species are hybridized, involves three steps : (1) isolation of somatic protoplasts, (2) fusion of the isolated protoplasts, and (3) culture of the fused protoplasts in a nutrient medium (Fig.1).

Isolation of protoplasts. Viable protoplasts can be isolated by treatment with cellulolytic enzymes such as cellulase, pectinase and macerozyme. Protoplasts were first isolated from cells of a root tip, using a fungal cellulase, by Cocking (1960). S. S. Bhojwani of the Department of Botany, University of Delhi, and E.C. Cocking (*Nature New Biology*, **239**) reported in 1972 another promising technique of isolating haploid protoplasts from pollen tetrads. The isolated protoplasts, when transferred to culture, can regenerate their cell walls and start dividing. Such protoplasts can be used either directly for parasexual hybridization or for the multiplication of the parental stock. It is now possible to isolate protoplasts under conditions which prevent their fusion and later transfer them to an appropriate medium to induce fusion.

Fusion of the isolated protoplasts. The first successful attempt to fuse isolated plant protoplasts was made by J.B. Power *et al.* of Department of Botany, University of Nottingham, U.K. (*Nature*, **225** : 1970). Fusion may occur spontaneously under certain conditions, but can be considerably enhanced by application of suitable chemicals such as sodium and calcium in appropriate concentrations; pH of the solution used is critical in bringing forth successful fusion. Fusion of protoplasts from

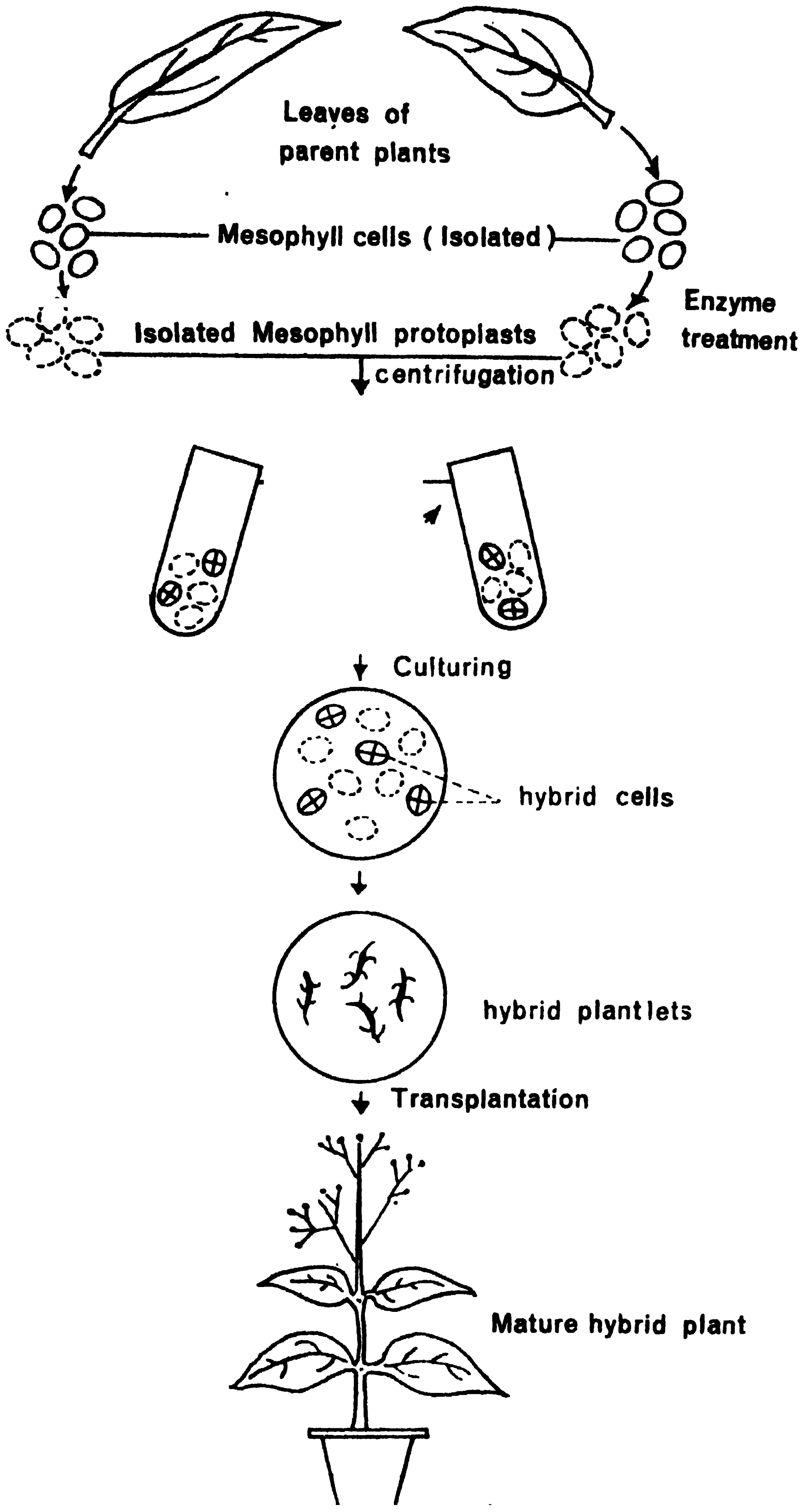

Fig. 1. Process of parasexual hybridization

two different species has now been observed in protoplast cultures of Maize × Oat, *Torenia bailloni* × *Torenia fournieri*, *Glycine max* × *Vicia hajastema*, *Petunia hybrida* × *Nicotiana tabacum* and *Nicotiana glauca* × *Nicotiana langsdorfii*.

Culture of hybrid protoplast. The hybrid protoplasts are transferred to suitable culture media under aseptic conditions to produce new clones that grow successfully in culture. These clones establish themselves, when transferred to soi, land produce flowers and fruits with viable seeds; they can also be grafted on to the parent stocks to make the scions mature into branches that produce flowers and fruits.

P.S. Carlson *et al.*, Department of Biology, Brookhaven National Laboratory, New York, U.S.A. (*Proceedings of the National Academy of Sciences*, U. S. A., **69** : 1972) were the first to utilize the technique of parasexual hybridization effectively. Using isolated mesophyll protoplasts of *Nicotiana glauca* and *Nicotiana langsdorfii*, they were able to produce plants with hybrid genetic constitution that produced flowers and fruits with viable seeds.

Culture of haploid cells

Microspores possess a true copy of every gene present in the diploid parent as a result of pairing and segregation during meiosis. Exploitation of this unique genetic potential is the basis of pollen culture for producing clones of cells and whole plants carrying a single set of genetic information (haploids). The discovery of S. Guha and S. C. Maheswari of Department of Botany, University of Delhi, (*Nature*, **204** : 1964) that haploid plantlets could be obtained from anther cultures of *Datura innoxia* gave an impetus to the utilization of haploids in higher plants.

Techniques of angiosperm pollen culture have not yet been perfected. However, mature pollen grains of *Brassica oleracea* have been induced to form 'cell cultures' in hanging drop cultures by T. Kameya and K. Hinata of Institute of Agricultural Research, Tohoku University, Japan (*Japanese Journal of Breeding*, **20** : 1970); colonies of green, parenchymatous cells appeared in culture within 28 days. Development of embryoids from pollen grains of *Datura*, *Lolium*, *Nicotiana*, *Petunia* and *Oryza* is similar to those of the true zygotic embryos into plantltes. When large numbers of plantlets are produced in one anther, they can be separated soon after the anthers open. Plantlets so separated are then transplanted individually in fresh culture medium. After these plantlets develop adequate root system, they are transferred to pots. The freshly potted haploid plantlets should be kept preferably in a moist atmosphere for a few days until the roots get established.

Plants derived directly from pollen embryoids are mostly haploids, as are plants derived from the first generation callus. Sometimes a few plants give rise to an inflorescence carrying both diploid and haploid flowers. This is due to endomitosis (cell division in which the chromosome duplication and chromatid separation takes place within the intact nuclear membrane and without the formation of a spindle, resulting in a large polyploid nucleus) at some stage in the development of the plant. Plants of higher ploidies (plants with multiples of the basic chromosome complement) may also be obtained from those regenerated from a callus. For instance, S. Narayanaswami and L. P. Chandy, Bio-Organic Division, Bhaba Atomic Research Centre, Bombay (*Annals of Botany*, **35** : 1971) have reported the occurrence of diploid and triploid plants derived from the anthers of *Datura metel;* only 7% were found to be haploids. In *Oryza sativa* plants derived from anther cultures have shown ploidy levels ranging from haploid to pentaploid. R. D. Iyer and S.K. Raina of Division of Genetics, Indian Agricultural Research Institute, Delhi (*Planta*, **104** : 1972) have shown that ploidy can be controlled by modifying the composition of the culture medium. So this method can be better adopted in ploidy breeding.

Pollen culture also offers considerable scope in the production of haploid mutants and in the phenotypic expression of mutation. Doubling of the chromosome complement of the haploid mutants leads directly to the formation of fertile and completely homozygous plants which retain the desired characteristics. This rapid method of producing homozygous plants is important in plant breeding and in programmes of crop improvement.

Genetic engineering is another area where haploid cell cultures are of potential value. Doubling the chromosome complement of haploid cells after introducing the gene for a desired character could lead to the production of homozygous plants with the introduced gene in duplicate. A successful attempt in this direction has already been made by Doy *et al.*, Department of Genetics, Research School of Biological Sciences, Australian National University, Canberra (*Proc. Australi. Biochem. Soc.*, **5** : 1972), by the transfer of genes controlling galactose metabolism, from the bacterium *Escherichia coli* to the haploid tissue of tomato. Likewise, attempts to transfer nitrogen fixing genes from micro-organisms to genotypes of higher plants, if made successful, could lead to an increase in the nitrogen content of food crops. It will also solve the problem of protein deficiency and related malnutrition.

Mutants from tissue culture

To incorporate new and useful genes into genotypes of cultivated varieties, plant breeders have several conventional methods of hybridizing the existing domestic varieties with wild ones. These methods often require vast areas of land, and considerable time and labour. To overcome this, selection of spontaneous and induced mutants from tissue cultures may be employed.

Spontaneous mutations

Recent techniques have made possible rapid isolation of spontaneous mutants in culture. It is now possible to grow a large number of isolated plant cells in a small area under aseptic conditions by proper manipulation of the culture media to regenerate embryoids, shoots or roots. In such cell cultures, spontaneous mutation may occur and the mutants can be isolated by proper techniques. The shoots developed from these mutant cells can be isolated and rooted by horticultural methods. The fact that large quantities of suspension cultures may contain only a few cells possessing a dominant mutation limits the scope of selection of spontaneous mutants from cultures. Only a few workers have succeeded in isolating spontaneous cellular mutants of potential agricultural value.

"And my theory is that a culture that grows out of mere tissue will tend to be vegetative."

Induced mutations

In addition to the selection of desired spontaneous mutant phenotypes, mutations can be induced in culture with the aid of mutagenic agents such as chemical mutagens and ionising and non-ionising radiations. This involves four steps: (1) production of callus or suspension cultures; (2) induction of mutations using mutagenic agents; (3) selection of desired mutants, and (4) regeneration of mutant plants. This may, no doubt, produce more desirable mutations than those occurring spontaneously in culture and may make selection of mutants easy. Mutating the seed or any propagules (plant parts used for propagation) may lead to the production of chimeras (a mixture of genetically different tissues) rather than mutation of the whole material due to their multicellular and differentiated nature. Production of chimeras can be avoided to a great extent by mutating the cells in culture or isolated pollen grains before fertilization.

Production of mutant plants from cell cultures encounters the following problems: (1) absence of suitable tissue culture techniques; (2) difficulties in selection of mutant phenotypes; (3) retention of mutant phenotypes in regenerated plants, and (4) appearance of cytological alterations which may lead to progressive loss of total potency.

Tissue culture could be a great boon to future crop improvement programmes. It hastens the availability of new varieties, with commitments of less land and labour, and time. Even with cultivars that are propagated through conventional asexual techniques, tissue culture can be utilized to boost up their rate of multiplication. But the techniques available are inadequate for the proper identification and selection of mutants in culture. Moreover, cytological instability of cells in culture leading to a progressive loss in total potency limits the scope of tissue culture in the present plant breeding programmes.

Further reading

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SOME FUNGI ARE HARMFUL TO HUMANS

Fungi play an important role in our daily life, but some of them are dangerous too

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UNLIKE most microorganisms, fungi have been quite useful to man. They are used for making bread, fermented drinks, cheese and, more recently, useful organic chemicals including antibiotics. Their role in nature is that of scavengers; they break down complex carbohydrates and proteins of dead bodies into simple molecules. Only a few of them are pathogens and most of those affecting man are facultative (organisms that can grow on both living and dead organic matter) rather than obligate (organisms which can live only on living matter) parasites.

Infections produced by the true fungi, or eumycetes, are called mycoses. Nowadays, there are as many deaths reported from mycoses in U.S.A. as from whooping cough, diphtheria, scarlet fever, typhoid, dysentery and malaria put together. Furthermore, the superficial fungal infections such as ring worm and athlete's foot, though not dangerous, are extremely common in India. In north and north-eastern or tarai regions in India, fungal diseases (mostly dermatomycoses) are common because of the ever prevailing moist conditions.

In India, research work on the pathology of mycoses is being done at the All India Institute of Medical Sciences, New Delhi, Institute of Medical Sciences, B.H.U., Varanasi and K.G. Medical College, Lucknow.

The fungal spores (soil-borne or air-borne) may reach an wounded part of the body, respiratory tract and its associated sinuses, conjuntivae or the ear canal, or may be ingested. Under normal conditions they are eliminated, but if the body defences are impaired some non-pathogenic organisms may establish themselves as 'opportunistic pathogens' or 'opportunist organisms.'

A majority of the pathogenic moulds, yeast, yeast-like fungi and dimorphic fungi belong to the group *Deuteromycetes* (*Fungi imperfecti*) including some members of *Phycomycetes* and *Ascomycetes*.

Distribution

As early as 1960, Dr. L. Ajello of the United States Public Health Service had discussed the geographic distribution of these fungi. According to him, of the twenty known species, eleven are cosmopolitan; *Trichophyton megninii* is European, *Microsporum nanum* has been reported from Cuba only, while a few are endemic to Africa.

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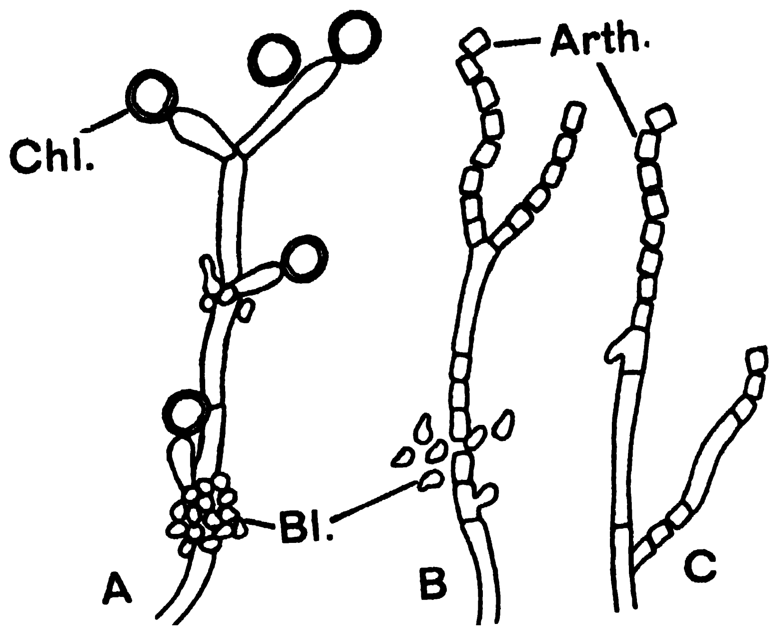
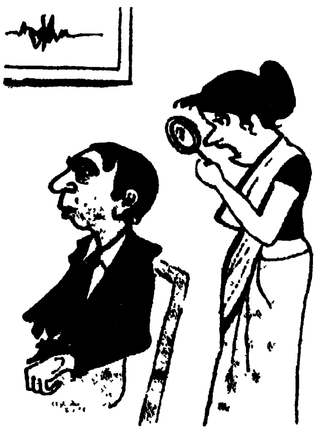


Fig. 1. A. *Candida albicans*, B. *Trichosporon beigeli*. C. *Geotrichum* sp. (Chl. Chlamydospore; Bl. Blastospore; Arth. Arthrospore)

The dermatophytes (fungi causing diseases of skin) are studied under two heads for convenience : those causing superficial infection wherein only epidermal tissues are affected, and those involving underlying deep tissues.

Agents of superficial mycoses

The fungi causing dermatomycoses have the unusual ability of digesting and utilizing keratin (tough fibrous protein containing sulphur), and are capable of parasitising the keratinous structures of the body, e.g., the horny layer of the skin, the hairs and the nails. They do not invade the underlying living tissues that form the keratin, or the deeper tissues and organs of the body.



'I need your scalp, dear, to study the fungi that cause dandruff"

Tinea or ring worm is caused by four genera of *Deuteromycetes*, viz., *Microsporum*, *Trichophyton*, *Epidermophyton* and *Keratinomyces*. In this affliction, the spreading edge of the lesion is commonly seen as a red inflammatory ring (5mm-50mm in dia.) studded with vesicles and pustules, while the recovering central region is scaly and less reddened. Infected hair become weak and are readily broken off to produce bald patches. In some cases they show characteristic green fluorescence under ultraviolet irradiation. Infected nails become deformed, discoloured, brittle and broken.

Inside the host, the fungi occur in only two forms: (i) as vegetative mycelium growing through the keratinous structures, and (ii) as chains of cylindrical or rounded thick-walled 'arthrospores', formed by segmentation and separation of hyphae. The arthrospores are capable of infecting intact skin but they infect more readily if the skin is subjected to minor injury by rubbing, scratching or prolonged moistening. Hyphae in skin, nail or hair eventually give rise to arthrospores. In hair, the arthrospore formation may be endothrix (from hyphae within the hair shaft; large arthrospores) or ectothrix (from hyphae growing over the surface of the hair; small arthrospores). In the latter case, the hair bears a thick white coat of spores (Fig. 3).

Among human dermatophytes, some, e.g., *Trichophyton mentagrophytes*, *T. interdigitale* and *T. sulphureum* can attack many parts viz., scalp and hair of the head (*Tinea capitis*), skin and hair of the beard region (*Tinea barbae*), skin of the feet (*Tinea pedis*), skin of the groin (*Tinea cruris*), skin of the other parts of the body (*Tinea carporis*) and the nails (*Tinea unguim*). The dermatophytic species are divided into anthropophilic, i.e., primarily parasites of man and rarely of other animals, and zoophilic, i.e., primarily parasites of some animals and only occasionally infecting man. Species that are anthropophilic include *Microsporum andouinii*, *Trichophyton interdigitale*, *T. rubrum*, *T. sulphureum*, *T. violaceum*, *T. schoenleinii* and *Epidermophyton floccosum*.

The fungus spreads by contact and through air in the form of arthrospores. They are highly resistant to environmental conditions and may remain alive for years in infected sites and survive in clothing even after many successive washings. A parasitic form, *Microsporum gypseum*, has been found in soil and is capable of growing saprophytically. It is believed that the soil may occa-

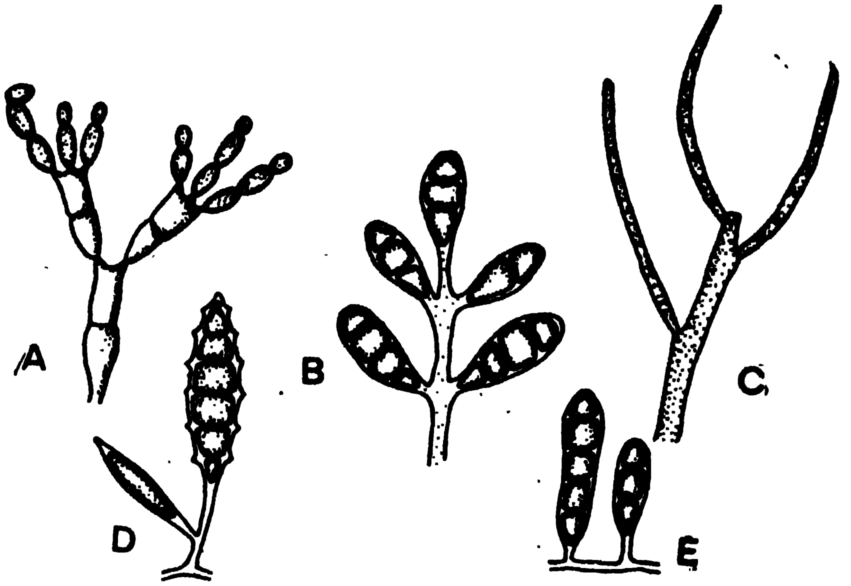


Fig. 2. A. *Hormodendrum* sp.; B. *Epidermophyton* sp. C. *Cercospora* sp. D. *Microsporum* sp.; E. *Trichophyton* sp.

sionally act as a source of infection to man and animals. Other fungal members causing superficial infections, invading hairs and horny layers (not necessarily digesting the keratin) include filamentous *Trichosporon beigelii*, the yeast-like organisms *Candida albicans* and *Malassezia furfur* and the yeast *Pitryrosporum ovale* (causal organism of dandruff).

Trichosporiasis, also called 'white piedra', is a disease of the beard and moustache caused by the fungus *Trichosporon beigelii*. Treatment —just shave it off.

Agents of deep mycoses

Deep mycoses are diseases of the human body which affect tissues below the outer skin. They are usually chronic and serious in their effects.

The cutaneous blastomycosis is usually a primary infection of the skin. There is papule and pustule formation followed by ulceration and a slow peripheral spread in the skin, but there is no systemic dissemination. The causative agent is a fungus—*Blastomyces dermatitidis*. Systemic blastomycosis usually results from a primary infection of the lungs with subsequent bloodborne dissemination to the skin. The source of infection is unknown and the fungus has not been found as a saprophyte in the soil or elsewhere. Presumably, it enters the body by inoculation through the skin or by inhalation into the lungs.

Certain species of *Geotrichum* are known to be pathogenic to man. Conant and coworkers (1954) of U.S.A. described four forms of geotrichosis : oral, intestinal, bronchial and pulmonary. The fungus produces terminal arthrospores and may also cause food and fruit rots (with lactic acid).

Sporotrichum schenckii causes sporotrichosis in humans and animals. The infection is chronic as nodules are firmly established in the subcutaneous tissue with subsequent inflammation and ulceration of the overlying skin. Primarily, the fungus is a saprophyte and can also infect living plants. Humans and animals are infected from contaminated materials through an injury to the skin.

Members of the family Dematiaceae, *Hormodendrum pedrosoi* and *H. compactum*, cause chromoblastomycosis, a skin disease in which masses of warty tissue are formed over infected parts of the body, usually the legs, feet, arms and hands. They live saprophytically on wood and vegetation and enter the body through leg skin injury caused by wood.

Maduromycosis or Madura foot in man is caused not only by actinomycetes such as *Nocardia madurae*, *N. pelletieri* and *Streptomyces somaliensis*, but also by a variety of fungi like *Madurella mycetonii*, *M. grisei* and *Cephalosporium falciforme*. These fungi are believed to occur as saprophytes in the soil and on vegetative matter. They enter the tissues of the foot through thorn pricks and other minor injuries.

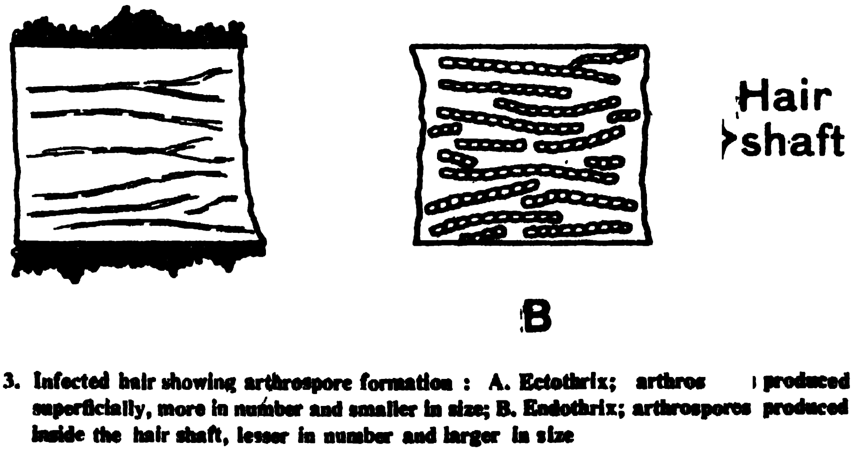


Fig. 3. Infected hair showing arthrospore formation : A. Ectothrix; arthros[illegible] produced superficially, more in number and smaller in size; B. Endothrix; arthrospores produced inside the hair shaft, lesser in number and larger in size

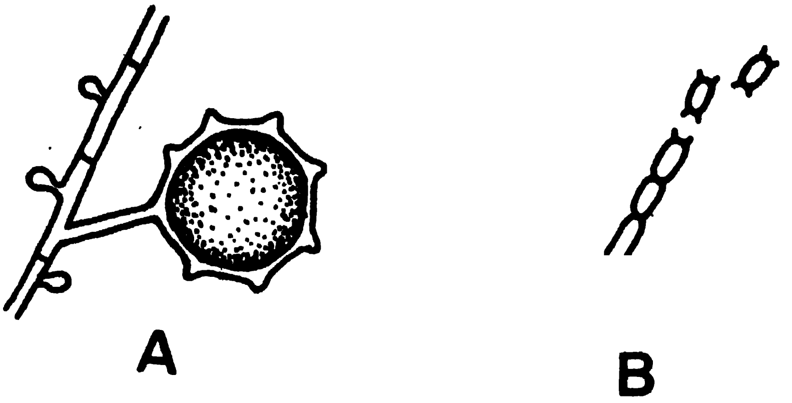


Fig. 4. A. *Histoplasma capsulatum* **with chlamydospores; B.** *Coceldiodes immitis* **with arthrospores**

Cercospora apii has also been reported as a human pathogen after its isolation from the thick leathery facial skin of a severely infected patient.

Diseases other than dermatomycoses

Various normally saprophytic species of *Aspergillus*, *Penicillium*, *Mucor* and *Rhizopus* are found in infections of the bronchi and lungs in humans and animals. *Aspergillus fumigatus*, *A. flavus*, and *A. niger* are animal and human pathogens which cause a group of diseases collectively known as 'aspergilloses'. In man, infection appears usually to supervene on a pre-existing pulmonary disease such as bronchitis, tuberculosis or pneumonia. It occurs most frequently in agricultural workers and others who inhale dusts of organic materials contaminated with fungal spores. The fungus may grow in the damaged bronchi or lung tissues and form a compact mass of mycelia called 'mycetoma'. In some cases broncho-pulmonary infection by *A. fumigatus* causes an asthmatic disease with plugging of bronchi by exudate containing mucus, fibrin and eosinophils.

The false yeast, *Cryptococcus neoformans* (syn. *Torula histolytica*), produces sporadic, but fatal infections known as cryptococcosis or torulosis in man and animals. Cryptococcosis may take the form of a pulmonary disease or a disease of the central nervous system called cryptococcus meningitis. The latter is serious, as it may lead to mental disorders.

Candida albicans (syn. *Monilia albicans*) is the only important pathogenic species in the yeast-like genus *Candida*. It is a common cause of acute and sub-acute infections (candidiasis or moniliasis) in man and animals. *C. tropicalis*, however, has been apparently found as the causal pathogen in oral and vaginal thrush but rarely in broncho-pulmonary infections. In 1954, Conant and coworkers (U.S.A.) recognized the following types of candiasis: candidiasis of mucous membranes (oral and vaginal thrush), cutaneous candidiasis (skin and nails, etc.), broncho-pulmonary candidiasis, and pulmonary candidiasis which is probably the most serious of all. Infection is generally dependent on a weakening of the body's defence mechanism, e.g., by diabetes, leukaemia, iron-deficiency anaemia, senility, alcoholism, etc. Infection of skin is promoted by prolonged exposure to moisture and lesions, generally localized in damp folds (intertriginous candidiasis), e.g., in the axillae, groin, infra-mammary areas, interdigital clefts, umbilicus and gluteal folds, etc.

One of the dimorphic fungi (fungi occurring in both mycelial and yeast-like forms), *Histoplasma capsulatum*, is the cause of histoplasmosis, a granulomatous disease in man. It usually occurs as asymptomatic infection of the lungs, or, rarely as a progressive, fatal systemic infection involving skin, upper respiratory tract, mouth and intestine. The fungus is found in the soil of endemic areas, but whether it grows in the soil as a saprophyte or enters the soil from infected animals is uncertain. Infection occurs due to inhalation of soil dust.

Coccidiodes immitis is another dimorphic fungus causing coccidiodomycosis, a granulomatous disease affecting man. It causes infection of lungs that spreads to skin, bones, meninges and other organs. The fungus occurs in the soil as saprophyte or perhaps is derived from infected animals. Infection is probably due to soil dust inhaled or introduced through injured skin.

Rhinosporidiosis is a chronic polyp-forming infection of the submucous tissue of nose, eyes, ears and larynx, and occasionally of the genitalia and skin. It is common in India and occurs sporadically in humans, horses and cows. The source of infection is unknown, though persons swimming in rivers and stagnant water are frequently infected. The causative organism, *Rhinosporidium seeberi*, has not been cultured, but its appearance in tissue indicates that it is a fungus.

Precautions

In view of the hazards of mycoses one should know how to minimise the number of deaths due to these microorganisms and how to check their transmission. The suggested precautions are:

1. Physical contacts with persons carrying dermatophytes should be avoided.

(*Continued on page* 757)

SCIENCE SPECTRUM

Mars is cloudy and windy

IN the past, man wrongly took Mars to be inhabited by intelligent beings. Likewise, he made wrong assumptions about the atmosphere of this planet. With Vikings there for more than a year, quite a detailed picture of Martian atmosphere is now available. No doubt the data collected by the earlier Mariner missions also enabled scientists to fill up gaps in the picture of Mars. And with the presumption that all that happens on Mars has not yet been revealed to the senses of Vikings, let us see what kind of world is that which has mystified man through ages.

Composition of atmosphere

It was previously deduced that atmosphere of Mars was not different from that of the earth. In other words, nitrogen should be present there in abundance and other gases in similar proportions. However, it is now found that carbon dioxide is abundantly available on this planet. It forms as much as 96 per cent of its atmosphere; 2.5 per cent of it is nitrogen, 0.1 per cent oxygen, and the rest is noble gases. The surface pressure is accordingly low. It is only 5 to 7 millibars as compared to the 1,013 millibars on the earth.

Why is there so much difference in atmospheric composition of these two close, similar planets? A planet possesses atmosphere, we know, when it releases gases from its surface during volcanoes or such like phenomena. Once gases envelope the planet, their "sticking" to it depends upon many factors, such as, the planet's gravity, the heaviness or lightness of the gas, the energetic rays falling on the planet, etc. Though it is easy to assume that Mars and earth were evolved in a similar fashion when solar system formed and they must have possessed envelopes of gases of almost similar composition, it is difficult to explain the contrast as found now. However, some explanation based on models has been offered.

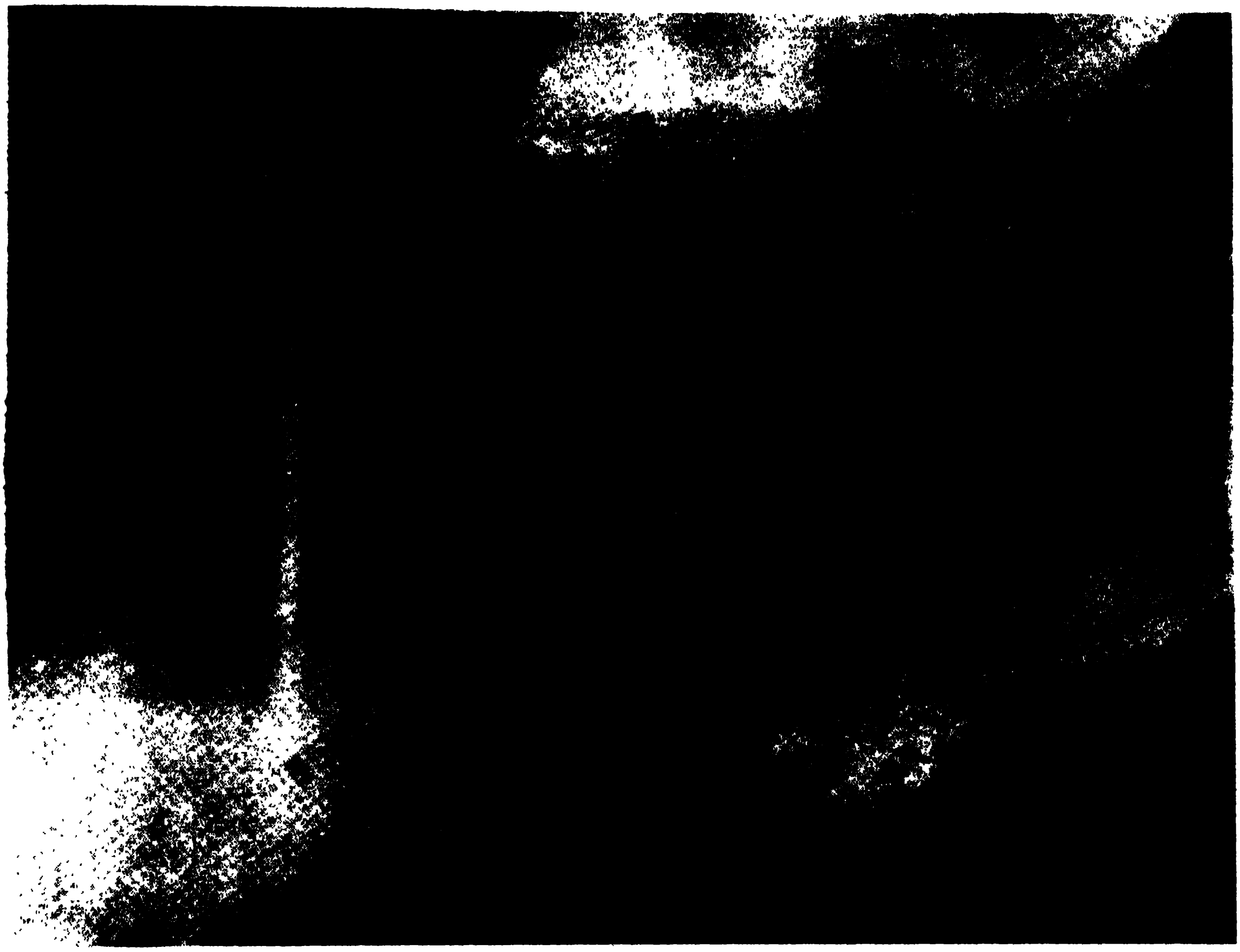
Mars is covered, unlike earth, with no layer of ozone. It is therefore not shielded from the ultraviolet rays coming from sun. These rays energise certain gases and, as the gravity of Mars is weaker than that of earth, it is easy for some to leak out of its atmosphere. On the earth, nothing of the kind happens except for a few gases. So even though Mars and earth began to evolve with atmospheres similar in composition, with the passage of time one difference produced another, and the process continued.

While nitrogen and oxygen leaked out of Martian atmosphere, carbon dioxide and water vapour remained there because of low temperatures. They circulated between the atmosphere and polar caps. On the earth, carbon got settled at ocean bottoms and beneath the rocks while carbon dioxide remained in the atmosphere in small quantities. Oxygen was released as life began to evolve, water vapour condensed to produce oceans, and nitrogen more or less remained "tied" to the atmosphere. This explains in a simple way the contrast now observed.

Climate

Speaking in terms of earthly conditions, Mars has a dry climate. But if the low pressure existing on its surface is taken into account, it has a highly humid climate. Like the earth, the humidity is not same at all latitudes. It increases with latitude. As Mars has no umbrella of ozone layer, its surface and atmosphere are directly exposed to the piercing ultraviolet rays coming from the sun. Apparently, some reactions take place. For instance, according to calculations, ozone, atomic hydrogen, carbon monoxide and hydrogen peroxide should be produced.

The escape of atomic hydrogen from the upper atmosphere of Mars has been detected by the Vikings while descending. Also, ozone in small amounts has been detected mostly in polar regions. The confirmation of the production of these two gases on Mars has proved our calculations to be right. Therefore, yet undetected carbon monoxide and hydrogen peroxide must also be produced there. The reason why the Martian soil appears oxidized (from the photos) is attributed to the action of hydrogen peroxide.



The vast Martian dust storm that occurred in February 1977. This was photographed by the *Viking 2* orbiter at a point 33,000 km. above the surface of the planet

The presence of clouds on Mars may not surprise any one. But the fascinating aspect of the Martian atmosphere is that it has, besides clouds carrying water ice (frozen water), also those carrying dry ice (frozen carbon dioxide). This is suspected on seeing the photos sent by the Vikings. The only difference in appearance between these two types of clouds is that, while water-ice clouds look diffuse, the dry ice clouds have sharp edges.

Like those on the earth, Martian clouds also grow and decay with remarkable regularity, indicating a day-to-day weather on this planet. The dry ice clouds are mostly found in the polar or higher altitude regions where temperature is low. It is also suspected that the dry ice snowstorms may also be occurring in winter and might have a hand in creating the famous seasonal dry-ice polar caps.

Martian winds are—like the terrestrial ones—westerly in direction upto a considerable altitude. 10 meter/ sec to 20 meter/sec is the typical wind speed recorded at the surface while greater than 100 meter/sec at an altitude of 10 kilometer. If these winds are to be compared with those recorded on earth at the same levels, Martian winds are fierce, so to say.

The most unexpected discovery that Viking made when it landed on Mars was the presence of ground fogs. While some low lying areas remain covered with fog throughout the day, in the rest it lifts with the rising of sun. It again spreads with the approach of the night.

The seasonal changes on the surface of Mars, which the Italian astronomer G. Schiaparelli attributed to the working of intelligent beings, were clarified by earlier Mariner missions to be nothing more than dust storms regularly occurring on this planet. Schiaparelli's conjecture now looks like a hilarious joke! Now that Mars' atmosphere has been probed, the reason why dust storms occur, to a certain extent, is clear. The

"Amazing! It is no different from our home atmosphere."

initiators are the fierce winds and the dusty atmosphere of the planet.

In the rarefied atmosphere of Mars, wind speeds, as high as 30 meter/sec to 60 meter/sec, are required to carry the grains. As there occurs no rain after the storms, the grains remain suspended in the air for weeks and months. It is due to them that Martian sky has a pinkish tint, just as our sky has blue. Sunlight scatters the dust to produce the tint. On a little prodding by the winds, the hanging dust causes dust storms. The game continues, on and on.

Apart from these earth-like local dust storms, storms on a global scale also occur on Mars. It is claimed that this phenomenon generally occurs once in a Martian year when the planet is closest to the sun in its elliptical orbit. The increased solar energy then falling on the planet causes it. However, the Vikings suspect that these global storms are more frequent.

The channels

The most baffling signs on Mars are the channels and soil which look eroded by water. The only explanation offered for these markings is that once upon a time floods appeared on this planet. This seems unlikely, as estimates show that no water in such large amounts have ever been present on the planet. Nor is there any likelihood that the planet had a warmer climate in the past, which is necessary for floods.

Conway B. Leovy, Professor of Atmospheric Sciences at the University of Washington, U.S.A., has offered an explanation (*Scientific American*, July 77) which sounds plausible. He claims that Mars had once been covered with water ice. Cataclysmic events, such as volcanoes or falling meteorites, may have made water ice to evaporate. What immediately followed was torrential rains which caused floods. May be, such a thing also happened on earth before oceans came into existence.

DILIP M. SALWI

Bubble chamber

SOMETIMES atomic particles disintegrate by themselves into two or more particles which are more elementary in nature. The newly generated particles take divergent tracks. With a vapour-filled cloud chamber, this rare occurrence cannot be recorded, as the probability of collision of the particle with gas molecules is very small. The collision probability can be increased either by increasing the pressure of the enclosed gas, or by introducing a series of lead plates in the chamber at the cost of length of the track. Compared to cloud chamber, a particle has a much higher collision probability in photographic emulsion (*S.R.*, Jan. 1977) as the dense emulsion makes collision a frequent affair. However, the particle trajectory is so crooked that the exact effects of a magnetic field cannot be measured. Also, it is difficult to protect the photographic emulsion completely from the all-pervading cosmic radiation that masks much of the useful tracks. These difficulties called for a new device, better than both the cloud chamber and the photographic emulsion. In 1952, this demand was fulfilled satisfactorily by Donald A. Glaser of Michigan University, USA, with the invention of a new detector called 'Bubble chamber'. For his ingenious discovery, he was awarded the 1960 Nobel Prize in Physics.

Principle of bubble chamber

We know that at boiling temperature, a liquid boils with effervescence. If the liquid is subjected to high pressure of the order of a few hundred atmospheres, it does not boil at its normal boiling point. This is because the boiling point of a liquid usually increases with increase in pressure. (Fig. 1) If the pressure is suddenly reduced, the liquid does not boil immediately but remains quiescent for some time. The liquid at this moment is said to be superheated. The quiescent period de-

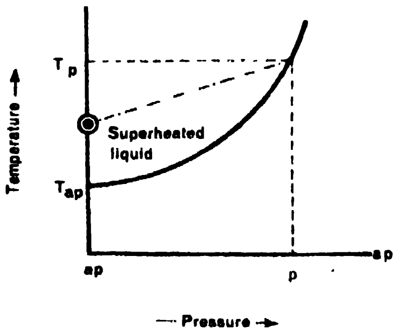


Fig. 1. ap-atmospheric pressure; P-superincumbent pressure: T_p-boiling point of liquid at p; T_{ap}-boiling point of the liquid at ap

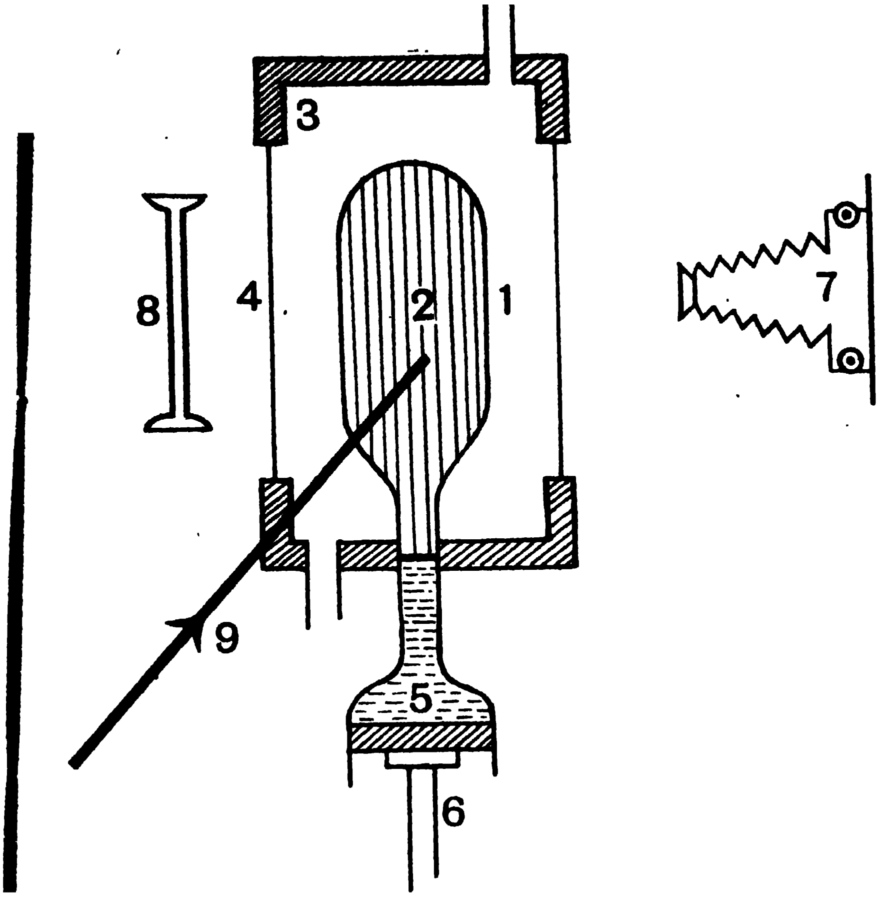


Fig. 2. Glass bulb (1); superheated liquid (2); oven (3); window (4); water (5); piston 6; camera (7); light source (8); ionizing radiation (9)

pends upon the nature of the liquid and the degree of superheating, i.e., the temperature above the normal boiling point. The greater the degree of superheating, the greater is this quiescent period. In a bubble chamber, this superheated liquid behaves like the super-saturated vapour in the cloud chamber.

Superheated liquids possess a sort of instability against bubble formation which is analogous to the instability of a supercooled vapour against drop formation. Glaser found that a charged particle triggers the formation of microscopic bubbles in a superheated liquid and it starts boiling. As a result, small bubbles form all along the path of the ionizing particle in the liquid. This produces a visible track. By illuminating the bubble tracks by photoflash, they can be photographed.

Structure of bubble chamber

A bubble chamber consists of a heavy-walled cylindrical pyrex bulb 3-4 cm long and 1-2 cm in diameter, which is filled with a suitable liquid. The liquid-filled chamber is immersed in a thermostat-controlled liquid bath (Fig. 2). By moving the piston, any desired amount of pressure can be applied to the liquid in the chamber to make it superheated. Generally, the liquid remains quiescent in this unstable state for several seconds, then violent boiling takes place. If during the quiescent period, an ionizing particle is allowed to pass through the chamber liquid, it leaves behind a string of bubbles. L. W. Alvarez of California University, USA, found that the performance of the bubble chamber is still better if the chamber volume is sufficiently large and the pressure of the compressed liquid is dropped rapidly.

Superheated liquids

The liquids used in bubble chamber must have certain specifications to get a clear record of the tracks.

(1) The liquid should be non-conducting, so that the charge of ions is retained; (2) it should have low surface tension, so that the force tending to collapse a bubble is weak; (3) it should have high vapour pressure which would tend to enlarge each bubble formed in the liquid, and (4) it should be more or less transparent, so that the bubbles formed by the penetrating ion can be photographed or even seen with the naked eye. Many pure liquids and some solutions satisfy these conditions. The choice is usually made on the basis of the nature of ionizing particle and the target material for study. In general, for all types of works, diethyl ether and liquid propane and pentane are used, as they are easily available and operate at convenient temperatures and pressures.

Uncharged particles do not ionize the molecules of the liquid and so do not produce tracks. To study X-rays, gamma rays and uncharged particles like neutrons and neutral pions, a highly dense liquid must be used in which a definite collision reveals its presence and position. For this purpose, liquids like stannic chloride or methyl iodide dissolved in propane, tungsten hexafluoride and xenon are used.

The quiescent period of a superheated liquid is an important parameter. If it is higher, rare nuclear reactions can be studied.

Table 1

Liquid	Chemical formula	Normal boiling point	Limiting temperature up to which the liquid can be superheated
Hydrogen	H	20	30
Xenon	Xe	166	255
Nitrogen	N	77	170
Trifluro methyl bromide	$CF_3 Br$	214	303
Propane	$C_3 H_8$	231	333
Pentane	$C_5 H_{12}$	309	393
Diethy lether	$C_4H_{10}O$	309	413
Dibromo difluro methane	$CF_2 Br_2$	298	420

The measurements with bubble chamber yield promising results. Energies of particles can be deduced from the depth of penetration required to stop them in the dense liquid. The nature of the electrical charge of the particle and its momentum can be determined by applying a transverse magnetic field and finding the curvature of the track. From the density of bubbles along a track, the charge and speed of the particle can be estimated.

Unlike cloud chamber, the bubble chamber is, however, not continuously sensitive. It takes some time to superheat the chamber liquid sufficiently again so as to record another event successfully. Even then, the bubble chamber has several important advantages over all other detectors.

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What is a tornado?

IN nature, we see many violent phenomena, like volcanoes, earthquakes, landslides, storms etc. To these can be added the tornadoes, which are one of the most violent and devastating atmospheric phenomena known to man. Their characteristics are fantastic; results utterly drastic. A tornado can be distinguished by its funnel-shaped cloud which extends downwards from the base of a turbulent cloud layer. It moves in an unpredictable path with the lower end of the funnel moving back and forth causing distruction wherever it touches the ground.

When two air masses with different temperatures and moisture contents meet, violent convection currents are set up. They produce spiralling movement of the air known as vortex motion which is the characteristic of a tornado. The centrifugal force of the whirl reduces the pressure within the vortex and rarifies the air. This rarefaction causes cooling which in turn causes condensation of water vapour releasing enormous amounts of energy. The difference between the atmospheric pressure and the internal pressure of the vortex is an important factor.

The direction of an impending tornado can be recognized easily from the sky. It will be as dark as it is during night. Strange coloured clouds are seen—black, greenish, purple etc. Clouds come together and break producing wild sounds. The shape and colour, of course, change according to the atmosphere, the most usual colour being grey. This is due to condensation of water vapour.

The funnel has three motions: (i) progressive, (ii) horizontal, and (iii) vertical. Because of these motions, it shows a peculiar property of moving from side to side. Also, it changes its shape and bounces up and down producing frightful noises. The tornado may be compared to a jumping gigantic snake. The series of pictures in Fig. 1 shows the different stages of development and decay of a tornado.

Where tornadoes occur

Tornadoes are most frequent in spring and early summer. They occur anywhere in the world, but most frequently in the great plains and valleys of America, namely, Missisipi, Ohio, and Lower Missouri Valleys. In India, occurrence of tornadoes is rare. However, there are records of their occurrence near Moradabad, Mawana, Gunnam and Delhi.

Dimensions

A tornado whirls at a tremendous speed. The greatest velocities are reached at the centre of the funnel. According to the law of conservation of angular momentum, the outer air currents must tend to move faster as they approach the centre. The speeds cannot be measured directly because no instrument is capable of withstanding that power. So they are obtained from the after-effects. The range lies between 135m/sec-175 m/sec., though

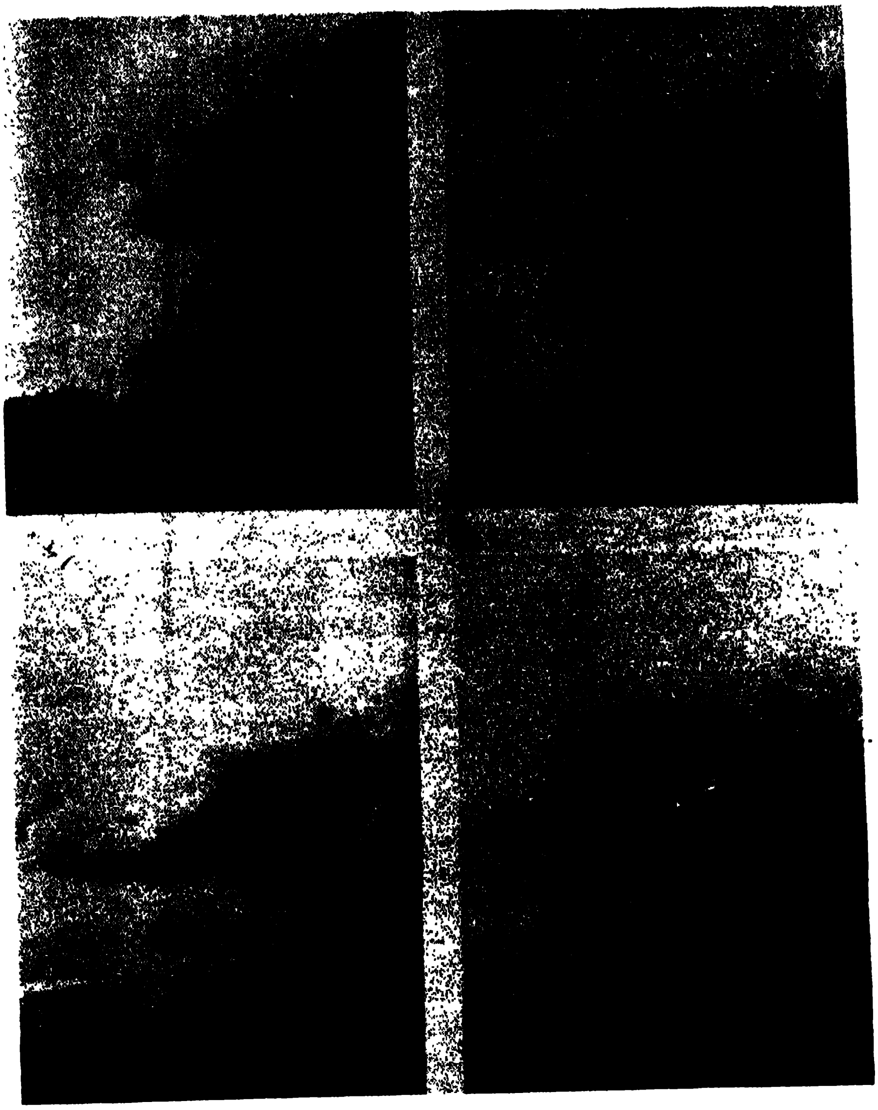

Fig. 1. Various stages of development and decay of a tornado near Manhalton, Kansas, U.S.A., May 31, 1949 (*Courtesy* : H. E. Dale and University of Oklahoma Press)

theoretical velocities above 880 m/sec. have been calculated. The length of the path of a tornado till it lasts varies between 250 meters-36,960 meters. The diameter of the funnel is usually a few hundred meters. The central pressure may be as low as 60%-80% of the normal atmospheric pressure, i.e., 600-800 milli bars. The central pressure has not yet been recorded directly as the centre rarely passes through a meteorological observation station.

To obtain the dynamics of the tornado, laboratory models have been developed, one of them by J. S. Turner of Woods Hole Oceanographic Institute, California, U.S.A. According to him, the whole of the vertical motion is confined to a cylinder around the axis. Near the axis is a region of up-flow and an annular ring surrounding this contains the compensating downward flow. In-flow takes place from the bottom of the funnel. The vortex is driven from place to place at the cloud region.

In order to study the vortex motion of the atmosphere, which is responsible for the formation of the tornado, modelling of vortex flows is being attempted. It has not yet been possible to identify the tornadoes by the use of radar pictur e. Research in this field is in progress.

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Environmental hazards of vanadium

ENVIRONMENTAL experts have recently issued a warning on the use of vanadium which according to them may act as a potentially dangerous pollutant and may adversely affect the productivity of farms and forest land. These experts, belonging to the Monitoring and Assessment Research Centre (MARC) at Chelsea College, London, have placed vanadium along with other potential environmental hazards like mercury, lead, cadmium and DDT. Some of them have already been included in the list of priority chemicals and are constantly being monitored by the Centre for any possible environmental damage.

Widespread interest in vanadium toxicity has been spurred by the recent discovery of high concentration of vanadium compounds in fly ash from combustion of residual petroleum products and coal from some parts of the world. In the United States alone, the atmospheric concentration of vanadium is reported to be about a million times higher than in south polar air.

The concentration of vanadium in coal and crude petroleum oil is low but appears to vary widely among different sources of coal or petroleum and within a particular oil or coal field. Vanadium is also present in certain lignites, shales, fireclays, asphalts, terrestrial plants, sea water and marine muds.

It also occurs in the blood of certain sea squirts and sea cucumbers where it forms upto 10 per cent of the blood cell pigment. Vanadium concentration in these animals is often 10,000 times that in the sea water in which they live. These creatures lie fixed to sea rocks and their fossilized remains account for the presence of vanadium in petroleum in some parts of the world.

The ores of vanadium are distributed mainly in Peru, Colorado, Utah, South-West Africa and Zambia. In India, substantial quantities of vanadium can be recovered as byproduct in the alumina plants during processing of bauxite.

Exposure

With the increasing production and use of vanadium, the handling of its different compounds has become an industrial health problem in many countries. Workers engaged in the manufacture of vanadium pentoxide from vanadium concentrated slag and ferro-vanadium in pelletizing plants, in the cleaning of oil and gas fired boilers, in refinery operations using vanadium as a catalyst, in glass and ceramic industry, in electronics and in smaller plant operations involving handling and grinding are exposed to the hazards.

On the basis of available information, from industrial experience and from experimental human and animal studies, the threshold values for vanadium pentoxide fixed by the American Conference of Governmental Industrial Hygienists are 0.5 mg/M^3 (for dust) and 0.05 mg/M^3 (for fumes).

As the MARC report has warned, there is a clear evidence that even a small amount of vanadium destroys soil fertility. It prevents mineralisation—a process by which nutrients are liberated from the fertilizer in the form required by plants—rendering the fertilizer useless and reducing crop yield. Vanadium in the soil is also said to interfere with biological nitrogen fixation which is essential for farm productivity. The presence of vanadium in the soil for a longer period may, therefore, prove catastrophic for agricultural production.

The presence of vanadium in atmosphere in metropolitan cities leads to high incidence of cancer, next only to smoking. A survey of air pollutants and smoking habits of persons in six European cities and North Wales revealed that incidence of lung cancer was due to cigarette smoke, vanadium and some other metals present in the air.

Symptoms

The earliest signs of vanadium poisoning are nausea, vomiting and intensive cough. The tongue gets blue-black and a blue line appears on the gums. Other symptoms are : sore throat, difficulty in breathing, loss of appetite, anaemia, emaciation, diarrhoea, blurred vision, severe-conjunctivitis often with suppuration, melancholia, dry paroxysmal cough, and albuminuria.

In order to protect workers and the general population from the hazards of vanadium pollution, routine of screening should be done of the population living in and around vanadium-based industries. Appropriate prophylactic and therapeutic measures should be taken so that vanadium poisoning does not become endemic. High doses of ascorbic acid (vitamin C) or an intraperitoneal administration of 10 per cent solution of calcium trisodium salt of diethylene triamine penta acetate is recommended in treating vanadium poisoning cases. These agents form soluble complexes (chelates) with vanadium and excrete the latter through urine.

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Indium, the "chewing gum" metal

THE first consignment of the ultra high purity indium produced at the Special Materials Plant of the Nuclear Fuel Complex, Hyderabad has been exported to West Germany. This is a part of an export order for 150 kg worth Rs. 3.5 lakhs.

The Special Materials Plant was set up at the Nuclear Fuel Complex, primarilly for producing ultra pure materials needed for the electronics industry. Ultra high purity indium is used in the manufacture of germanium transistors. It is also used in the manufacture of flux-free, low melting soft solder. The process of production of this material from crude indium, developed initially at the Chemistry Division of the Bhabha Atomic Research Centre, was adopted at the Special Materials Plant for regular production on a large scale.

The metal which Ferdinand Reich of Freiberg School of Mines, Germany and his assistant discovered in 1863 remains one of the rarest of the elements, although the price has fallen from the $40,000 valuation which its discoverers placed on each of the two pencil sized samples. It was named indium because it gives an indigo coloured line in spectrum.

Usually, indium is found in zinc ores associated or compounded with another rare metal, gallium. It is extracted as hydroxide which is then reduced to obtain metallic indium. Ultra high purity indium is made from this by a special process. It involves multistage electrorefining of crude indium in an aqueous solution of indium sulphate. Electrorefining is done by using anodes of crude indium and cathodes of highly pure indium. The cathode deposit so obtained is cast into ingots under vacuum.

The metal is soft and silvery white. It is lighter than zinc, more lustrous and less tarnishable than silver; melts in a match flame at a temperature of 155°C and is so soft that you can dent it with your thumbnail. In fact, pure indium can be chewed like chewing gum—if you have good strong teeth.

The indigo metal entered industry in the form of a dental alloy. Indium-gold alloy inlays have greater strength and ductility, and also more resistance to tarnishing than any other alloy known to dentists.

Indium was used in special bearings for making propellers of aeroplanes in World War II. These steelsilver-lead-indium bearings also performed excellently in tanks, jeeps and other mobile equipment which are assigned heavy duty. Zinc-indium coating on hollow steel propeller blades of ships protect them from rust.

Large amounts of this metal added to gold produce a blue gold. The colouring is accompanied by a desirable hardening of gold.

Pure silver that has slight amount of indium diffused into its surface resists blackening or tarnishing when exposed to sulphur bearing atmosphere present in homes that use coal as a fuel.

Added to silver solders and other brazing alloys in quantities as small as 1 or 2 per cent, indium produces a harder, stronger brazing material. Moreover, these indium solders have a high degree of wettability, so much so, in fact, that they can be used to solder metals to glass.

Indium takes a very high polish and for this reason it has been used in plating special mirrors.

Ultra high purity indium is used for p-doping in semiconductor technology (particularly germanium transistors) and in the manufacture of flux-free low melting soft solders in the electronics industry.

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Role of zinc in plants

ZINC is well-known to us as a mineral micronutrient (partially mobile) essential for normal growth of plants. However, our knowledge of its role in plant physiology and metabolism is far from satisfactory. As early as 1869, J. Raulin (France) suggested that traces of zinc were necessary for the growth of the fungus *Aspergillus niger*. Definite evidence in support of zinc requirement for higher plants was first provided in 1941 by P. Maze of Pasteur Research Institute, Paris, who showed that without addition of zinc, normal growth of maize plant would not occur. In 1928, A. L. Sommer of the University of California proved the necessity of zinc for several higher plants including barley, sunflower, broad beans, kidney beans and buck wheat.

Effect of zinc on growth

R. T. Policarpochkina and E. E. Khavkin of Sibirskii Institute, Irkutsk (U.S.S.R) reported in 1971 that inadequate supply of zinc inhibited growth of roots and leaves in maize plants, formation of lateral roots (isolated from maize plant), and reproduction of tobacco tissue cells in suspension culture, confirming the necessity of zinc for cell division. Increase in the dry matter production in maize plants with the application of zinc has also been observed. Sommer's earlier experiments on bean plants demonstrated that zinc was essential for reproductive processes. Delay in flowering due to zinc deficiency in maize plants has also been noticed. E. Polar (1975) at Cemece Nuclear Research Centre, Turkey, suggested that zinc in pollen grains plays an important role during fertilization. A reduction in yield of many crops like beans, paddy, wheat and maize has been found due to zinc deficiency.

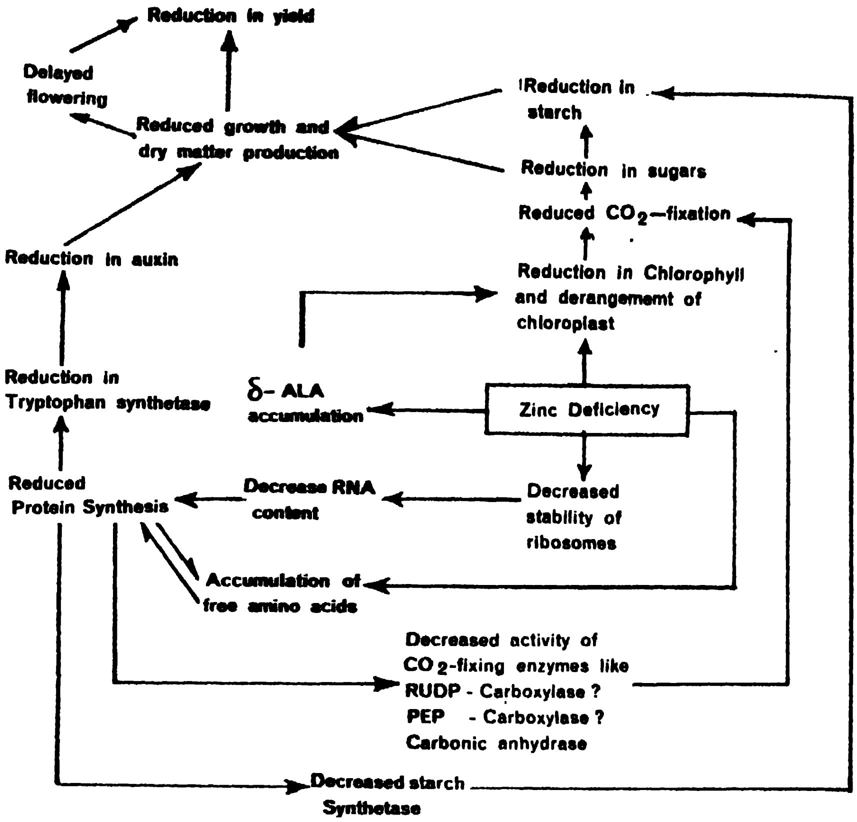
Reduction in yield
Delayed flowering
Reduced growth and dry matter production
Reduction in starch
Reduction in sugars
Reduced CO_2—fixation
Reduction in Chlorophyll and derangememt of chloroplast
Reduction in auxin
Reduction in Tryptophan synthetase
δ- ALA accumulation
Zinc Deficiency
Reduced Protein Synthesis
Decrease RNA content
Decreased stability of ribosomes
Accumulation of free amino acids
Decreased activity of CO_2-fixing enzymes like
RUDP - Carboxylase ?
PEP - Carboxylase ?
Carbonic anhydrase
Decreased starch Synthetase

Fig. 1. Effect of zinc deficiency on growth, yield and metabolic changes in plants

Plant metabolism

Zinc is involved in several metabolic functions of plant including auxin metabolism, protein synthesis, nucleic acid metabolism, carbohydrate metabolism, etc, Chlorophyll content decreases under zinc deficiency. It might be due to the accumulation of δ-ALA (a precursor of chlorophyll biosynthesis) or non-availability of Mg^{++} at the site of chlorophyll synthesis. It has also been found that $^{14}CO_2$ fixation rate is reduced under zinc deficiency, which might be due to the inhibition of some enzymatic activities in the dark reaction of photosynthesis. Not only CO_2 fixation but also the intermediates of the carbon assimilation cycle are affected. For instance, there is an increase in glucose, fructose, and sugar phosphates on the one hand and decrease of sucrose contents on the other. This suggests that zinc has some role in sucrose biosynthesis as well. There is decrease in the rate of RNA formation just prior to the onset of growth inhibition under zinc deficiency.

The cytoplasmic ribosomes of *Euglena gracilis* contain a significant amount of zinc and these organelles become extremely unstable in zinc deficient conditions. A decreased incorporation of ^{32}P in nucleic acids in rice plants, increase in amide, total amino nitrogen compounds and amino acids have been reported under zinc deficiency. This increase in amino-acids is usually accompanied by a decrease in the protein content of the plant. Prof. C. Tsui at the University of Wisconsin (USA) suggested in 1948 that zinc is required for the synthesis of tryptophan which is a precursor to auxin (a plant hormone) biosynthesis. Additional support for the role of zinc in tryptophan synthesis has been provided by the report that the activity of enzyme tryptophan synthetase is markedly reduced in *Neurospora* grown under Zndeficiency. The action of gibberellic acid increases by zinc in bean internodes.

A number of zinc metalloproteins have been identified in higher plants, algae, fungi, bactera and animals. All zinc-dependent enzymes are metallo-proteins—the metal being firmly or covalently bonded to the protein.

Histological effects

In zinc deficient plants, the palisade and mesophyll tissue in leaves become abnormally compact, the number of palisade cells decreases and the cell becomes 12-16 times larger than the normal cells. The number and size of chloroplasts are reduced. The root-tip cells accumulate tannins, calcium oxalate crystals and oil globules. In maize, the mesophyll chloroplasts become swollen and the bundle sheath chloroplasts become "comma shaped" and devoid of starch grains.

Deficiency symptoms

Lack of zinc produces indistinctive symptoms in plants, associated with retardation of normal growth and lack of chlorophyll. The effect of zinc deficiency on crop plants has been variously described as "little leaf" of lemon, "sickle leaf" of cocoa, "bronzing" of tung, "little leaf" and "rosette" of apple, "white bud" of maize, and "dieback" of citrus. Among the most characteristic symptoms are shortening of internodes, reduction of leaf size to 5%-10% of normal size and various forms of chlorosis. Root growth also decreases and produces irregular swellings behind the root apex where root hairs normally develop. The symptoms have been observed to appear first in older leaves in tobacco, tomato, peas and french beans, while in maize, both young and old leaves may show the symptoms. Initial symptoms are a light interveinal chlorosis of older leaves, which rapidly progresses to form a broad bleached stripe, severe stunting of plant follows and pollination is poor.

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They are not all mosses

Moss is the common name given to lower green non-vascular plants belonging to the class musci, a sub-division of Bryophyta. These plants usually form thick greenish carpet on earth surface, walls, woods or even on rocks. But the term "moss' is loosely applied to a number of unrelated organisms which show only certain superficial resemblances. The following are some of the false mosses of the plant kingdom.

Algal mosses

Mosses are formed by algae. The blue green algal organism, Protococcus, sometimes forms a greenish film called "moss" on tree trunks, posts and stones. It is interesting that these algae grow only on the north side of the trunk. It is not known why it is so.

The *Carragheen moss* or Irish moss of commerce is represented by the red alga, *Chondrus crispus* (Fig. 1a). It is the best known and most widely used food alga in western Europe. When mixed with cold milk, seasoned with vanilla or fruit, it turns into a delicious food known as Blancmanges in Europe. Carrageenin is extracted from this "sea moss."

The moss often associated with reindeer covers large areas in northern Europe and America. It is a lichen formed by the combination of two unrelated organisms, the algae and fungi. A typical example is *Cladonia rangiferina.* The reindeer principally depends on these plants and hence the name.

Scale mosses

Scale mosses are leafy liver-worts belonging to hepaticae of Bryophyta. Under the class hepaticae there are both thalloid and leafy forms. *Takakia* (Fig. 1b), which is considered to be very primitive, has leaves compo-

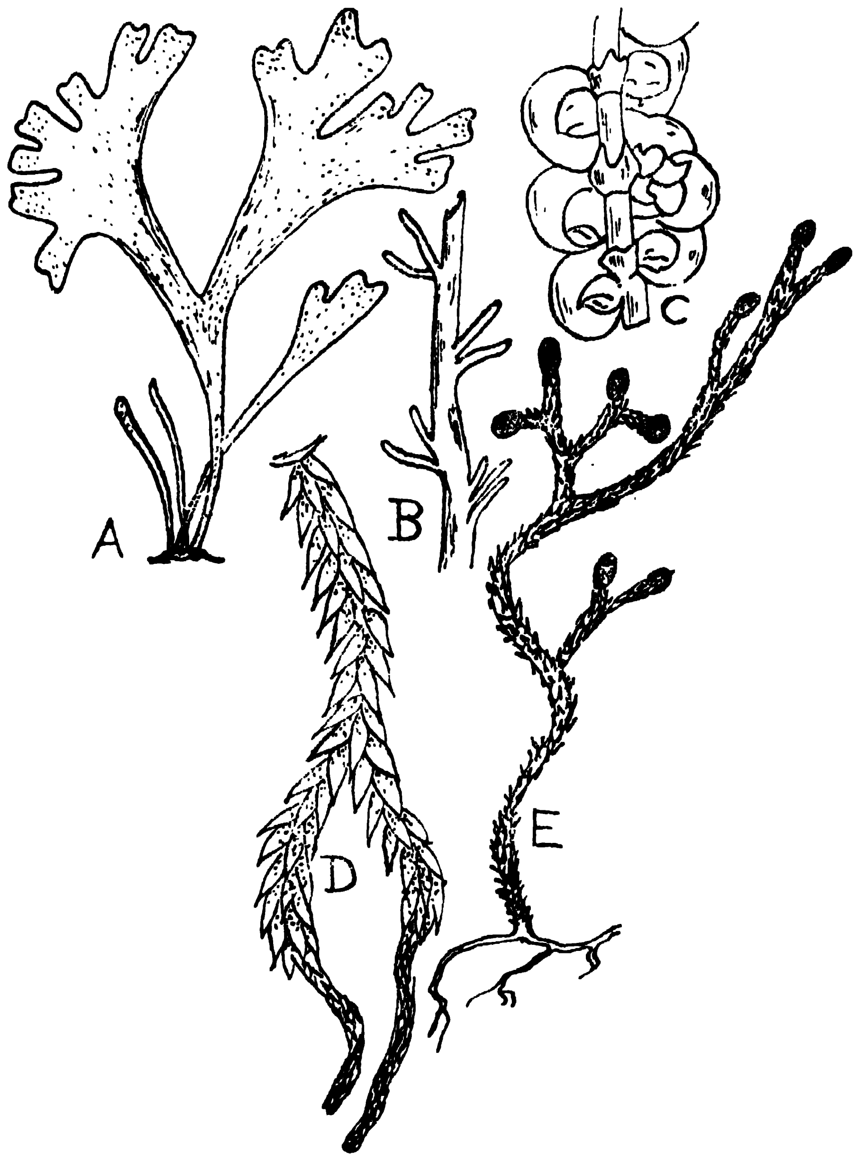

Fig. 1. (a) *Chondrus crispus:* (b) Takakia; (c) Frullania; (d & e) club mosses

sed of two hair-like segments. The leafy members are usually recognised by the presence of two rows of leaves. In certain cases it may show three rows; two rows composed of large leaves and one row of small leaves. In *Frullania*, the plant has a small pouch-like lobe bent up behind the main portion of the leaf (Fig. 3). The leaves have entire or serrate margins.

Club mosses

Those who study botany can never forget the common "Club mosses", the name given to the genus Lycopodium (Figs. 1d and e) of the class Lycopsida under pteridophytes. They have a worldwide distribution but are mainly confined to the tropics with upright, branched or sparsely branched, creeping or pendulous habits. There are viny forms also.

The leaves are microphyllous or macrophyllous with simple or serrate margins and with a single central vein. The stellar systems are well developed and are made up of tracheids. The gametophyte in club mosses is often associated with an endophytic fungus. Because of their peculiar size and snake-like appearance, these mosses are called the reptiles of the plant world.

Spanish moss

The Spanish moss is an Angiosperm living strictly as an epiphyte on various substrata. *Tillandsia usneoides* is a typical example which shows extreme epiphytism by attaching itself even to telephone wires.

Tillandsia is rootless and hence the organs of absorption are hairy outgrowths distributed over the surface of the plant body.

It is clear from the above examples that the word "Moss" is wrongly used in everyday speech to describe many kinds of plants which do not belong to the moss family, but have only certain superficial resemblances.

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What are nucleosomes ?

CHROMOSOMES were described in the 1880s as rod-shaped and condensed bodies, always present between the two poles of dividing plant and animal cells which become clearly stained when treated with specific dyes. During non-dividing stages of the cell, the chromosomes become greatly extended and appeared as a network of tangled fibres. Even in this extended or dispersed form, the staining patterns were observed to be similar to those of the chromosomes. These stainable fibres were called chromatin. This term continues to be used even today, although we now know they are the strands of DNA complexed with proteins and other organic or inorganic compounds.

The chromatin fibre may be considered as the basic structural unit of the chromosomes in higher organisms. It consists of a continuous linear DNA duplex strand associated with basic proteins called histones, acidic proteins called non-histones, various amounts of RNA, and enzymes such as DNA and RNA polymerases, among others. While all other components vary proportionately histones occur in an equal proportion, by weight, to DNA in the chromatin fibre.

Histones

Histones were discovered in the late 19th century, but it was not before 1943 that Edgar Stedman and Ellen Stedman of the University of Edinburgh specified some role to them. Their calculations of the histone contents of cells suggested that actively growing tissues contain less histones than the non-growing tissues. They concluded that histones function as inhibitors of biological activity. According to their data, they were correct in postulating an inhibitory function for histones, but as we know now, their measurements of histone contents were inaccurate—the histone contents of active and inactive cells do not vary. The bio- found in the nucleus. But when more DNA was added to the system, inhibition was reversed. This suggested that the histones blocked transcription (the RNA synthesis on DNA template) by binding to DNA and not by inhibiting the activity of RNA polymerase (the enzyme that catalyses RNA synthesis). At about the same time Vincent Allfery and Alfred Mirsky of the Rockefeller University, showed that when histones were removed selectively from isolated nucleus, the rate of RNA synthesis increased. Both types of experiments led to the conclusion that histones normally function as chemical evidence of the inhibiting role of histones came in 1962 from the experiments of Ru-Chih Huang and James Bonner of the California Institute of Technology, California. They showed that adding histones to a test-tube system, in which all ingredients of RNA synthesis are provided, inhibited RNA synthesis. They further proved that maximal inhibition of RNA synthesis was observed when a histone-to-DNA ratio becomes 1:1, a ratio in which histone and DNA are normally

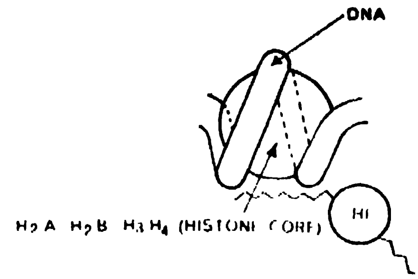

Fig. 1. A "nucleosome" formed from two molecules each of the histone H2A, H2B, H3 and H4. The 200 base pairs of DNA coils round the histone bead which had a diameter of about 106 angstrom. Separate nucleosomes are linked by histones H1. (After R., Lewin. 1976, *New Scientist*, 17 June, p.623). Each nucleosome is a spherical particle of about 115 angstrom diameter

regulatory molecules to inhibit the capacity of genes to synthesize RNA.

The histones, however, can be best defined by their chemical characteristics : they are proteins, rich in the basic amino acids arginine and lysine, but completely lacking the amino acid tryptophan. Because of their basic nature they can readily be extracted with acids like dilute hydrochloric acid and sulphuric acid. They can be fractionated into five principal classes, H1 (H5), H2A, H2B, H3 and H4 (Bradbury, E. M. 1975, *Ciba Foundation Symposium* 28, American Elsevier. N. Y.), most of which are present in the cells of all higher organisms. These five classes of histones fall into three groups on the basis of their relative contents of basic amino acids lysine and arginine. The three groups are: (1) Lysine-rich (H1), (2) Slightly lysine-rich (H2A and H2B), and (3) Arginine-rich (H3 and H4).

The lysine-rich histone class H1 displays microheterogenecity, that is, it can be fractionated into four components, each having a similar amino acid sequence composition and about the same molecular weight. This class is least tightly bound to the chromatin and therefore may be concerned with the surface properties (Lewin, B., 1974, *Gene Expression*, Vol. II, Wiley-Interscience). The two classes of slightly lysine-rich histones, H2A and H2B, show some conservation between different species. On the other hand, the two classes of arginine-rich histones, H3 and H4, show extensive conservation because of the practically identical amino acids sequence. They show conservation in organisms as unrelated as cow and carp (H3) and cow and pea seedlings (H4). Such a conservation mechanism of histones suggests a function common to different species—presumably structural, rather than regulatory.

Chromatin structure and histones

If histones have a structural function, then how are they organised in the chromatin? In 1974, after biochemical and X-ray diffraction studies of chromatin, Roger Kornberg of the MRC Laboratory of Molecular Biology, Cambridge, suggested a model for chromatin taking into account the properties of histones. The essential facts of the model are: (1) Chromatin contains roughly one of each type of histones per 100 base pairs of DNA, except for histone H1. (2) X-ray patterns reveal a structure repeating along the length of the chromatin fiber; H4, H3, H2A and H2B are required in the structure, but H1 is not. (3) Two each of H4 and H3 combine to form a tetramer, and two each of H2A-H2B combine to form a oligomer per 200 base pairs. (4) Certain nucleases (enzymes that digest or breakdown DNA) cleave almost all the DNA in chromatin to pieces of about 200 base pairs. (5) Chromatin fibres are often extensively coiled or folded.

These facts lead to two proposals: (1) Chromatin structure is based on a repeating unit of two each of H4, H3, H2A and H2B and about 200 base pairs of DNA, and (2) A chromatin fiber consists of many such units forming a flexibly joined chain.

According to the model "If one were able to take the DNA out of a chromosome and stretch it out, it would look rather like a long necklace with no gaps between the beads." The beads are now popularly known as "Particles on-a-string" or "nu" bodies (A. L. Olins, and D. E. Olins, 1974, *Science*, 183, 330) or nucleosomes (P. Oudet, *et al.*, 1975, *Cell*, **4**, 281) (Fig. 1).

Various electron microscopic, biochemical and nuclease digestion experiments have supported Kornberg's model. One of the most important supports comes from the experiments of P. Oudet, M. Gross-Bellard and P. Chambon of the Faculty of Medicine, Strasbourg, France. They have electron microscopically and biochemically confirmed that the length of DNA in each bead is about 200 base pairs. Neutron diffraction studies of J. P. Baldwin *et al.* (*Nature*, 1975, **253**, 245) on nucleosomes have proved that DNA is gently coiled on the outside of a histone core. This fact has also been supported by many other recent studies. Nonetheless, it is not yet clear whether the arrangement of histones in nucleosomes is random or restricted.

The high degree of conservation of histones, as mentioned earlier, might suggest that the DNA length per subunit of a nucleosome is also conserved. However, the existence of real differences in the DNA length of the nucleosome repeating between species or even cell types cannot be ruled out (N. R., Morris, 1976, *Cell*, **8**, 257).

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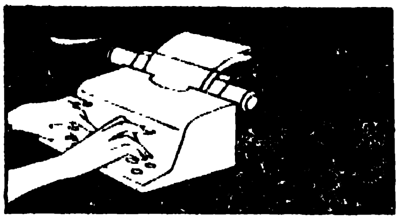

NEWS & NOTES

Nobel prizes 1977

Physics

THREE scientists share this year's physics Nobel prize for their researches in solid state physics. They are Sir Nevill F. Mott, 72, of the Cavendish laboratory, Cambridge, Prof. John H. Van Vleck, 78, of Harvard University and Dr. Philip Anderson, 55, of Princeton University.

Sir Neville's early work at Cambridge related to quantum mechanical effects on the scattering of alpha particles and atomic collisions. In 1930's, after he moved to Bristol, his interest turned to the solid state. There he made notable contributions to the theory of crystal dislocations, theory of fracture and other aspects of the structure of solids and also developed a theory of ionic crystals. One of Mott's outstanding contributions was the discovery of 'Mott transition' which explained why a material shows metallic or non-metallic property in the crystalline state.

Back in Cambridge, Mott invited Philip Anderson to Cavendish laboratory in 1961, and over the subsequent years they did pioneering experiments on the electronic structure of amorphous substances. Their new theories led to the development of devices such as semiconductor switches and opened up possibilities of making cheap solar cells from non-crystalline materials.

Philip Anderson started his research career with studies on magnetism under Prof. Van Vleck at Harvard. In the 1940's he developed a new theory of the antiferromagnetic state of metals. During his stay at Cambridge, Anderson also did fundamental studies on helium-3 and on the application of the solid state theory to astrophysics. But it was his work on the electronic structure of amorphous substances and on magnetism which earned him the Nobel prize.

Prof. John Van Vleck, known as the "father of magnetism", was the first to extend in the early 1930's the quantum theory to explain magnetic phenomena. His work on the nature of chemical bond, particularly in relation to magnetic properties, helped in devoloping the ligand or crystal field theory of molecular bonding. In 1932 he published the first edition of his *Theory of Electronic and Magnetic Susceptibility* that set out "in a completeness and clarity which quite belie the date" the modern theory of magnetism. Subsequently he developed and clarified many aspects of the electromagnetic nature of crystals and also made important contributions to microwave and resonance spectroscopy.

Chemistry

Prof. Ilya Prigogine, 60, of the Universite Libre of Brussels gets this year's Nobel prize for chemistry for research on statistical and non-equilibrium thermodynamics. (Thermodynamics is the study of the laws governing processes which involve heat changes and the conservation of energy.)

Born in Moscow, Prigogine emigrated to Belgium at an early age, and has spent his whole career there. His early research work was based on some scientific papers on the 'cell theories of liquids' put forward in the 1930's by Lennard Jones. Prigogine extended the theories to cover liquid mixtures also. Simultaneously with his researches on liquid structure and molecular theory of solutions, Prigogine was also trying to sort out certain contradictions arising out of the second law of thermodynamics when applied to open systems. (The laws of thermodynamics are generally applicable only to closed systems in equilibrium such as a gas enclosed in a cylinder and are true only for reversible processes. In case of an 'open' system, like a living cell, these laws do not hold true.) Prigogine developed thermodynamic theories to explain such non-equilibrium or irreversible systems. His theories have added a new dimension to our understanding of the physical world and will no doubt have far-reaching impact on the development of biological sciences as well.

Physiology and Medicine

The award for physiology and medicine is shared by three American endocrinologists. Dr. Rosalyn Talow, 56, of new York's Bronx Veterans Administration Hospital gets half of the $ 145,000 prize for developing the technique of radioimmunoassay for estimation of hormones in blood. The other half is shared by Dr. Roger Guillemin, 53, Director of the Salk Institute San Diego, California and Dr. Andrew Schally, 50, of Veterans Administration Hospital, New Orleans, for isolating, characterising and synthesising three polypeptides involved in the control of the anterior pituitary gland in brain.

Although basically trained as a physicist (she has a Ph. D. in that subject), Dr. Yalow was among the pioneers in the application of radioisotopes to clinical medicine. In 1947, she joined the newly formed radioisotope unit of the Bronx Veterans Administration Hospital where she has worked ever since.

The radioimmunoassay technique was developed by Dr. Yalow and her late co-worker Dr. Solomon A. Berson in the 1950's during their studies of hormone action in blood. The introduction of the new technique for the estimation of insulin concentration in human blood plasma started a revolution in endocrinology. It soon found use in other fields like clinical pharmacology, enzymology, oncology, virology, haematology and immunology. It could be used not only for assay of insulin in blood but also for other peptide hormones including growth hormone, parathyroid hormone adrenocorticotropins and gastrin. It was soon extended to other non-hormonal substances like enzymes, viruses, and several drugs including antibiotics, morphine, LSD and barbiturates.

The radioimmunoassay method is based on the binding reaction between antigens (e.g., polypeptide hormone, enzyme, etc.) and specific antibodies. Labelling of an antigen with a radioisotope makes it possible to measure its binding with a limited amount of specific antibody having a known inhibitory effect. The unknown concentration of the antigenic substance in a sample can then be found out by comparison.

The works of Drs. Guillemin and Schally, though done independently, concerned the same problem, namely, the function of peptide hormones in the brain. It was known earlier that the action of the anterior pituitary gland is mediated by a neurohormonal mechanism involving transport of chemical substances from the hypothalamus (an organ located in the centre of the brain). Guillemin and Schally succeeded in isolating, characterising and synthesising three of the polypeptides involved, namely thyrotrophin releasing factor (TRF), gonadotrophin releasing factor (GnRF) and somatostatin (or somatotrophin release inhibiting factor, SRIF).

The discoveries of Guillemin and Schally have already proved significant for clinical and basic medical sciences. Synthetic TRF and GnRF are now widely used in the investigation of thyroid dysfunction and infertility, respectively.

Biman Basu

Obituary

Lord Adrian

Lord Adrian, who shared the 1932 Nobel Prize for physiology or medicine with Sir Charles Sherrington "for their discoveries regarding the functions of neurons" died in London on August 5, 1977 at the age of 87. While Lord Adrian worked and taught at Cambridge University, Sir Charles did so at Oxford. As in the case of most of the Nobel-winning scientists, his research work will continue to illumine the path of researchers.

Lord Adrian is remembered for amplification of nerve impulses by radio-type amplifiers (a technique evolved first by Gasser and Erlanger who won the 1944 Nobel Prize for physiology or medicine). During the 1920's, Lord Adrian, in collaboration with Dr. Yotterman, divided the muscle of a frog until it contained just one sense organ and submitted it to an external stimulus, and amplified and recorded the sound in response to the stimulus. Contrary to the previous belief, they came to the conclusion that the more pronounced the stretching of the muscle, the more frequent were the impulses. Another of Lord Adrian's discoveries was that sense organs can and do adjust to a prolonged change in stimulus.

After 1934, Lord Adrian devoted himself to a study of the electrical activity in the brain. His work in this direction provided new leads in the understanding and treatment of epilepsy and in the location of cerebral lesions.

Born on November 30, 1889 in London, Lord Adrian studied at the Westminster School and Trinity College of Cambridge University with which he was associated most of his working life in one capacity or another, earning his master's degree in medicine in 1915. He then rendered medical service during World War I. For sometime, he also worked at St. Bartholomew's Hospital.

Lord Adrian started his academic career as a Lecturer in Physiology at Cambridge University (1920-29), later became Foulertin Professor of Physiology at Cambridge (1937-51). Thereafter, he served as Chancellor of the University of Leicester but returned to his *alma mater*, Cambridge, in the same

Lord Adrian

capacity. He was raised to peerage as the First Baron of Cambridge in 1955 and was appointed a trustee of the Rockefeller Institute, New York in 1962. He was elected a Fellow of the Royal Society as early as 1923 and was awarded the Order of Merit in 1942.

He is author of three books, *The Basis of Sensation* (1927/28), *The Mechanism of Nervous Action* (1932), and *The Physical Background of Perception*.

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An Interview

Prof. Chakravorty

SOMETIMES, it is fascinating to know how a now reputed scientist became interested in science in his childhood. Besides, we also get to know what most interests a child in science. How his interest can be sustained so that he blooms into a top ranking scientist.

Prof. Animesh Chakravorty, who won the 1975 S. S. Bhatnagar Award for his researches in chemical sciences, tells something about his childhood which should be an eye opener to our school teachers. "I vividly remember", he says, "how excited I was when our science teacher told us that matter is molecular in nature". That the three states of matter indicate different arrangements and different mobilities of molecules thrilled him. This sowed in him the seeds of science.

Later, in college, one of his friends presented him a copy of Linus Pauling's *Nature of the Chemical Bond* as a birthday gift. "This was a gold mine for me", he says. He began to do self-study in the exciting field of inorganic chemistry. So when in 1950s, inorganic chemistry was emerging as a discipline based on powerful unifying principles—a renaissance was almost on—he took up research in it. Besides, parents, teachers and colleagues constantly encouraged him to continue his research.

We can popularise science among children, Prof. Chakravorty says, through museums, well-equipped laboratories in primary and secondary schools and through colourful illustrated inexpensive books. "Can we not do this?" he asks.

Born on June 30, 1935, at Mymensingh (now Bangladesh), he grew up in an environment of science. His father was a reputed eye specialist. He had his early education in Mymensingh and Calcutta, and later did M.Sc. and D.Phil. from Calcutta University. He is presently Head, Department of Chemistry, I.I.T., Kanpur.

Prof. Chakravorty's major research is on the structure and properties of molecules in which a metal ion is surrounded by organic or inorganic groups. Such groups are called ligands and the entire molecule is called a complex compound. The molecules of such compounds have sometimes fixed shapes, but at times, the shape changes back and forth between two or more alternatives. The electrons in such molecules may be very mobile and may undulate back and forth between the metal ion and the surrounding ligands. On occasions, it is possible to add or subtract one or more electrons to such molecules. This process is called "redox".

Prof. Chakravorty

In some cases the same molecule may contain more than one metal ion. When this happens, the electrons of one metal ion often interact with the electrons of another metal ion. This produces peculiarities in magnetic properties. Using many techniques, Prof. Chakravorty has studied these varied phenomena. He and his team have made many new molecules and have also fabricated necessary equipment from indigenous components for their studies.

Prof. Chakravorty has been impressed by the methodology of research in the U.S.A. "The most important propellant is," he says, "hard work in laboratories and cross fertilization of ideas in meetings and seminars." The single-minded devotion to work that he saw in the West, he claims, is yet to pervade in our country. "We need to import this creed of hard work," he says.

Dilip M. Salwi

XV International Congress of Paediatrics

'HE XV International Congress of Paediatrics was held recently in New Delhi. The Congress was attended by about four thousand delegates from eighty-five countries, including those from different parts of India. It was the largest gathering of international experts ever held in India. Among the distinguished scientists who attended the Congress were Dr. Frederick C. Robbins, a Nobel laureate from the United States, Dr. A. Ihsan Dogramaci, President of the International Paediatric Association from Ankara, Turkey, and Prof. Andrea Prader of Switzerland.

The theme of the congress was "Breast feeding with love leads to better child health", a theme most appropriate for a setting like India where breast feeding has been advocated and practised since time immemorial.

Considerable time was devoted to the topic of breast feeding which in recent time has been established to be of great importance in preventing the new born against infections. Dr. L. A. Hanson of the Deparment of Immunology, Institute of Medical Microbiology, University of Goteborg, Sweden, said that several components of human milk, viz., lactoferrin, lysozymes, bifidus factor, phagocytes, T and B cells and antibodies play an important role in protecting the human neonate from infection. Immunoglobulin antibodies (IgA) consitute the dominant secretory antibodies in the human milk. They are constantly secreted throughout lactation. The secretary IgA antibodies are presumably locally produced in the mammary gland. He also presented evidence on the presence of antibodies against food protein in the human milk which possibly may help prevention of allergy in a baby. Dr. A. E. Olszyna Marzys of the Institute of Nutrition of Central America and Panama, Guatemala City, reported that his studies reveal high levels of DDT, dieldrin and heptachlor epoxide in human milk. This he said was due to environmental contamination.

Dr. Dogramaci said that three quarters of the world's child population suffer from hunger and lack both preventive and curative medical care. He cited that in Punjab the mortality rate is 72 times greater than in Sweden for 1 to 2 years old children. Of the over 80 million children born every year in the developing world, five million die of diphtheria, whooping cough, tetanus, polio, measles and TB while twice as many are disabled through brain damage, paralysis, stunted growth, deafness or blindness. Dr. Dogramaci pointed out that proper use of vaccines could have eliminated many of these diseases as has been achieved in many developed countries.

Among the topics for symposia were, in general, those covering nutrition, metabolism, infections, gastrointestinal disorders, cardiovascular systems, neurology, psychiatry, oncology, medical education, growth and development, endocrinology, etc.

ZAKA IMAM

Biochemist Bodansky passes away

DR. Oscar Bodansky, a pioneer in the use of biochemistry for the detection of various diseases, especially cancer, died on August 21 in New York. He was Chief of the Division of Biochemistry and a Vice-President of the Sloan-Kettering Institute for Cancer Research from 1966 to 1971 when he retired. Author of *The Biochemistry of Diseases*, a 1281-page text book, first published in 1940 and of *Biochemistry of Human Cancer*, published in 1975, Dr. Bodansky made many important and lasting contributions. His original and imaginative investigations on enzymes, their relations to, alterations during, and usefulness in the diagnosis of various diseases earned him a wide and well-deserved reputation as a distinguished medical researcher. His contributions to biochemistry and its application for diagnostic purposes were recognized in 1962 when he was awarded the Aloan Foundation Award. He also received the Van Slyke Award in clinical chemistry in 1965 and the Lucy Wortham James Award for clinical investigation in cancer in 1973.

Born in Elizabethgrad, Russia on August 21, 1901, young Bodansky came to the U. S. A., received his Ph.D. degree from Columbia University in 1925 and M. D. from the University of Chicago Medical School in 1938. He taught various subjects in Columbia University, University of California, University of Texas, New York University, and Cornell University. During the World War II he served as Chief of the biological section of the medical division of the Army's Chemical Warfare Service (1942-45) and as Director of medical research of the service's medical division (1945-56). He joined the Sloan-Kettering Institute in 1948.

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Seminar on restructuring of practicals relevant to theory

A U. G. C. sponsored seminar on restructuring of chemistry practicals relevant to theory was held at Andhra Loyola College in Vijayawada from 8-15 October, 1977. Over 40 participants from all over India participated in the seminar. The aim of the seminar was to acquaint experts with the actual laboratory techniques and experiments in modern branches of chemistry.

The topics covered modern fields of chemistry like chemical engineering, biochemistry, industrial chemistry, ion exchange, chromatography, drugs, pesticides, perfumes, etc.

The general opinion was that lectures should be reduced to a minimum and chemistry should be taught through more laboratory experiments. Greater stress should be given to practicals relating to everyday life, so that students realise the extent to which chemistry affects our life. Experiments on preparation of plastics, analysis of grass, milk, ion exchange and chromatography were included in the seminar.

The seminar brought out the need for introducing open-ended experiments, where neither the teacher nor the student knows the results of the practicals, thus making theory available through discussion at the end of the practicals. This would require a change in the evaluation methods so that the students are evaluated not on the basis of results of the experiments but on the basis of their theoretical knowledge and their capacity to apply it in the laboratory.

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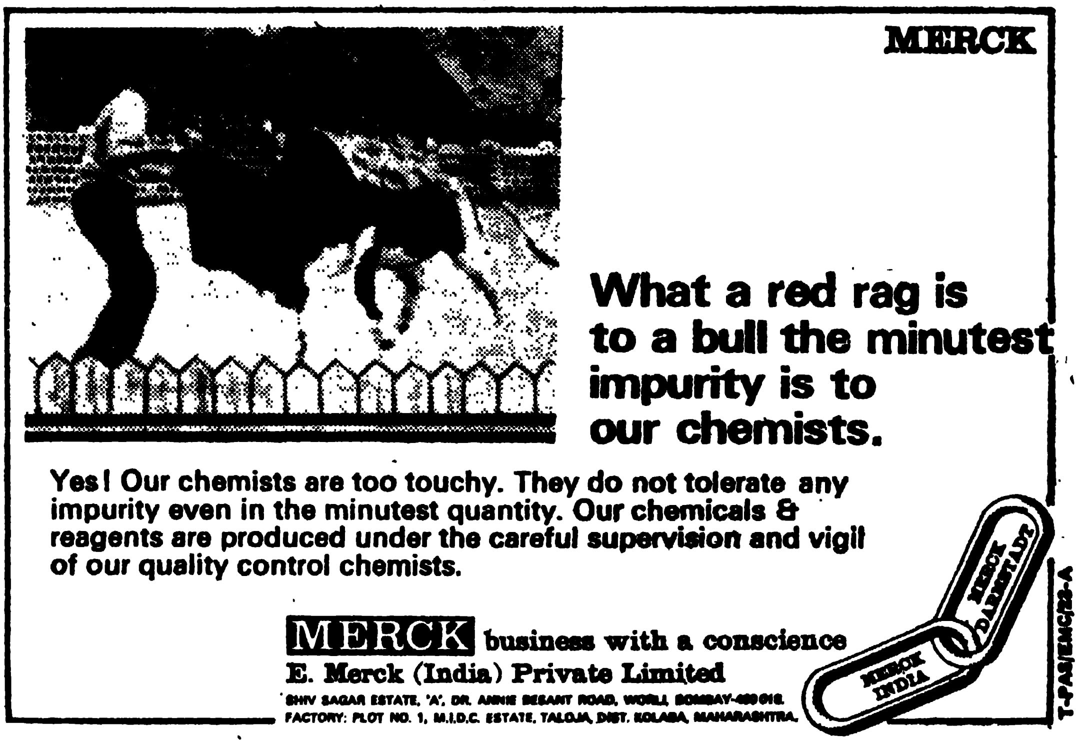

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MEDICAL NOTES

Is "Caulerpol" Vitamin A_3?

IT is a well-known fact that vitamin A_1 or retinol is obtained exclusively from such animal products as butter, egg fat, blood, and fish liver oil, etc. Paul Karrer and R. Morf (1931-1933) were the first to characterize and elucidate the structure of vitamin A_1. Later, J. G. Baxter and C. D. Robeson (1940-1942) were able to obtain it in pure crystalline form. Vitamin A_2 (2-dehydrovitamin A_1) was discovered by M. Shantz in 1948 from pike livers.

Prof. A. J. Blackman of Department of Chemistry, Tasmania University, Hobart, (Australia), and Dr. R. J. Wells of Roche Research Institute of Marine Pharmacology, Dee Why, N. S. W. (Australia) have, in 1976, jointly isolated and characterized a new diterpene alcohol, very closely related to vitamin A, from a marine algae *Caulerpa brownii*. The new substance isolated by them is a colourless oil, b.p. 120°C (0.1 mm), and has been named *Caulerpol* (*Tetrahedron Lett.*, No. 31, 2729-2730, July 1976). Caulerpol is a tetrahydro derivative of retinol; it is therefore, as is apparent from its structure, 7, 8, 11, 12-tetrahydrovitamin A_1 (Fig. 1).

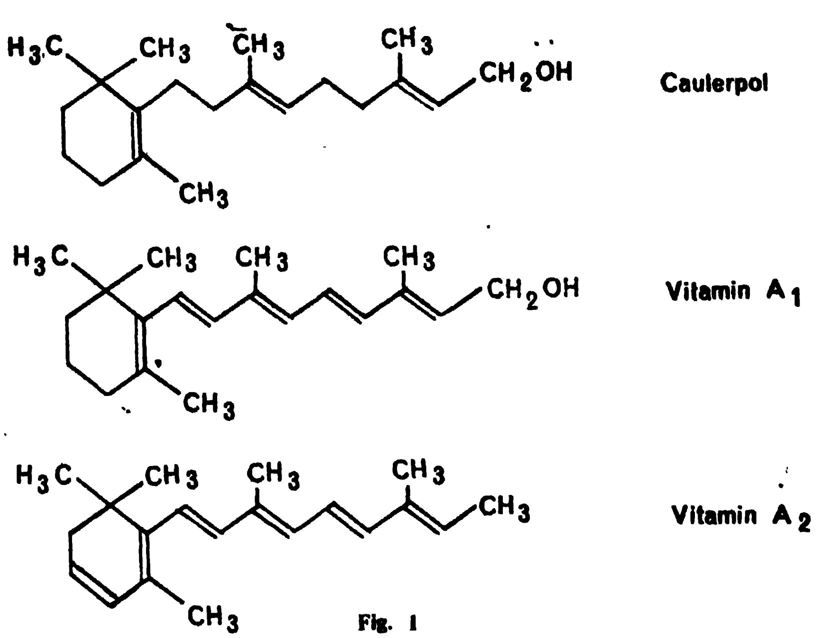

Fig. 1

It is interesting to note that whereas vitamins A_1 and A_2 occur in nature only in animal organisms, caulerpol would appear to be the first compound reported with the same carbon skeleton from plant sources. A compound of this structure is quite natural on biosynthetic basis and is so closely related to vitamins A_1 and A_2 that it is likely to be declared vitamin A_3. Moreover, like vitamins A_1 and A_2 the configuration of conjugated double bonds in caulerpol is also *trans*.

Previously, several *Caulerpa* species (Chlorophyta) were investigated by various workers and shown to contain triterpenes, xanthophylls, and certain nitrogen-containing compounds, but the isolation of caulerpol—a diterpene alcohol of vitamin A family—is undoubtedly of great significance. For the isolation of caulerpol, Blackman and Wells collected *Caulerpa brownii* algae from Cook's Corner, Freycinet Peninsula, East Coast of Tasmania, and subjected it to exhaustive extraction at 0°C with a mixture of chloroform and methanol (1:1, v/v). The concentrated extract was partitioned between hexane and aqueous methanol. The material from hexane solution was purified by dry column chromatography on silica gel eluted with hexane-chloroform mixture. In this way a 9.5% yield of caulerpol (based on dry weight of algae) was obtained. Interestingly, a small amount of caulerpol acetate was also recovered along with free caulerpol.

The physiological and pharmacological properties of caulerpol are yet to be invesigated. Only when this is done it would be possible to declare precisely, if caulerpol is vitamin A_3.

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A new antiepileptic drug for children

SODIUM valproate represents a new approach to the therapy of epilepsy. It is useful for children whose epilepsy has not been controlled with conventional drugs. Sodium valproate raises the concentrations of gamma-aminobutyric acid (GABA), a naturally occurring inhibitory transmitter in the brain. It also inhibits experimentally induced seizures in animals and clinical trials have shown it to be an anti-convulsant in man. Because of its short life, sodium valproate must be taken three or four times a day, a total dose in children beginning with 30 mg/kg/day, increasing upto 50 mg/kg/day. The drug should be taken with food to reduce anorexia (loss of appetite) or nausea which are more likely to occur in children than in adults. The drug is relatively non-toxic and its unwanted side-effects are very mild even at higher doses.

It was observed that apparent side-effects, if any, are usually due to potentiation of the side-effects of other anti-convulsants given. For instance, the dose of either phenobarbitone or primidone already being given may have to be reduced, if drowsiness occurs—and it may sometimes be profound. The reason for this is, that sodium valproate increases the serum concentration of phenobarbitone and related substances by inhibiting the metabolism of the compounds. It also increases the serum concentrations of phenytoin and it is possible that this is not only a potential cause of toxic effects but also a factor in some of the improvements obtained.

Sodium valproate is very useful in the treatment of petitmal in children. In a study with ten children having petitmal, only one failed to improve. The other nine achieved complete control, seven of them having been treated unsuccessfully with other drugs. Six of them remained free from petitmal for two years while taking sodium valproate and had no significant side-effects (*Dev. Med. Child. Neurol;* 17, p. 743, 1975). It was also found that sodium valproate along with the treatment of children with intractable epilepsy reduced the frequency of fits; children most helped are those with grandmal or petitmal. In addition, children who got relief from epilepsy from this drug also showed improved alertness and school performance. The drug has to be given regularly, atleast at eight-hour intervals; preferably at six hour intervals, because of its short halflife.

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FOR HER *(Continued from page 795)*

practice, 5 mg folic acid supplement ensures adequate supply.

Anaemia due to vitamin B_{12} deficiency in pregnancy is comparatively uncommon. The mean vitamin B_{12} level in the serum of the mother during parturition normally is 190 micrograms per ml, while it is 390 micrograms per ml in the infant's serum. A single injection of 40 micrograms of vitamin B_{12} is enough to produce maximum response in 10 days in mothers who are deficient in it, but usually larger therapeutic doses are recommended.

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SCIENCE FOR THE YOUNG *(Continued from page 799)*

are made up of a network of threads of almost invisible fineness, along which are minute loops made up of special cells arranged in a ring. When an unsuspecting eelworm crawls into one of these rings, the cells of the loop instantly expand, and tighten on the worm, gripping it firmly. The more the worm struggles to free itself, the tighter the loop becomes. When the worm is finally exhausted, the fungus sends in special branches which then suck nutrients from its body leaving only the skin, like a shell.

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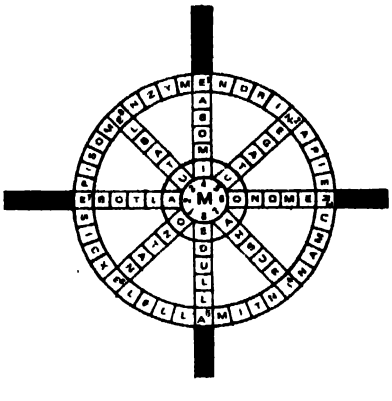

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FOR HER

Nutrition of a pregnant woman

PREGNANCY is a remarkable anabolic process (synthesis by living tissues of complex molecules from simpler ones) whereby out of food, vitamins, minerals and hormones, a 3.2 kg infant with 300 ml blood, 500 gm proteins, 30 gm calcium, 15 gm phosphorus and 300 mg-400 mg iron takes shape in nine months. If nutrition of the mother is inadequate, the constituents required are drawn from her body reserves and she becomes weak. The incidence of premature births rises with a decrease in the nutritional status of pregnant women. Low birth weights, low vitality and more early deaths are frequent among infants born to poorly nourished mothers. Improvement in the nutrition of the mother is, therefore, of prime necessity to improve the status of infants.

In addition to supplying requirements for foetal development and growth, the mother needs additional nutrients to meet; (1) 20-25 per cent increase in basal metabolism in the later stages of pregnancy, (2) formation of the placenta, and (3) blood loss during parturition. The diet of the mother should therefore be adequate for the additional requirements.

Calories. About 2000 calories a day are recommended for a mother of 45 kg. The figure is higher for those of larger build.

Proteins. During pregnancy, additional protein requirement of the foetus, placenta, etc., is about 950 gm., roughly estimated at 0.5, 3.0, 4.5 and 5.7 gm daily during each successive 10-week period. In order to convert this amount of tissue protein, an additional daily 10-12 gm of mixed protein allowance for the mother is necessary. Lactating women produce daily 850 ml-1000 ml of milk. Assuming 1 per cent protein in human milk, the daily excretion is 10 gm. Therefore, about 25 gm extra protein per day is recommended for the mother.

Carbohydrates and fats. Carbohydrates and fats should be supplied as in ordinary diet to provide necessary calories.

Vitamins and minerals. For the infant to be born with adequate stores, vitamin deficiency should not be allowed to occur during pregnancy. Ideally, the diet should supply all the vitamins (Table 1), but since this is not always feasible, one tablet of a multivitamin preparation should be administered daily.

Calcium. The calcium requirement increases particularly during the last 3 months of pregnancy when bones of the foetus are ossifying. About 25 mg of calcium is required daily by the foetus during the third month. But the demand gradually increases till daily 300 mg is necessary in the ninth month. If additional supply of calcium is not available in the diet then the calcium stores in the bones of the mother are depleted. In extreme cases, this leads to osteomalacia, a condition of morbid softening of mature bones due to deficient mineralization.

Anaemias in pregnancy

A pregnant woman is called anaemic if, from the 28th week onwards, the haemoglobin content is less than 10gm/100 ml of blood (70 per cent). In pregnancy, 550 mg of iron is required for the formation of foetus (400 mg in foetus, 100 mg in placenta, and 50 mg in uterine muscles.) About 175 mg is lost during parturition and 180 mg is excreted in the milk during lactation. On the other hand, there is also a saving of about 225 mg of iron which would have been lost during nine menstrual cycles. Thus the total loss of iron to the mother during each pregnancy is about 680 mg if the infant is breast fed and 500 mg if it is not.

The demand for folic acid or folate (a member of vitamin B group) increases because of increased cellular proliferation. Premature infants are sometimes born to folate-deficient mothers but the incidence is reduced with folic acid supplements. The requirement of 'free folate' is 300 microgram during pregnancy and 400 microgram during lactation. In

(*Continued on page* 794)

Table 1. Requirements during pregnancy and lactation

Calories	2000-2500
Proteins	70-90 gm
Vitamin A	6000 units
Vitamin B_1	1.5 mg
Riboflavine	2.0 mg
Nicotinic acid	15.0 mg
Folic acid	5-10 mg
Vitamin C	45 mg
Vitamin D	4000 units
Calcium	1.5 gm
Iron	15 mg

SCIENCE FOR THE YOUNG

The mermaid mystery

THE might and majesty of the oceans have attracted the attention of man through the ages. Many legends are associated with it. The ocean is credited to have counterparts of animals and man living on land. Though highly evolved groups of animals inhabit the seas, it is certain that it has none resembling humans. The poetic fancy however invented mermaids and mermen living in depths of the ocean. It is interesting to look into the facts leading to the origin of this myth.

In ancient times, sailors used to narrate stories of mysterious creatures they encountered while on sea voyage. People were fascinated by these stories, because of the exaggerated versions of the observed phenomena. Many secrets of the oceans were not known to science at that time. The origin of mermaid myth is an example of fact intertwined with fancy.

Sea cows, *Dugong* (Fig. 1), are marine mammals belonging to the group *Sirenia*. They feed on sea weeds at the bottom and only occasionally come to surface waters to breathe. These animals have the habit of holding their calves in between their forelimbs while nursing. This appears like a woman breast-feeding her infant, especially when viewed from a moving ship at a distance. It becomes evident however that such a resemblance does not hold good when the animal is watched from close quarters. The other marine mammals that give an appearance of human face are sea lions, walruses and seals. But unlike the members of the *Sirenia* group, they do not possess fish-like tails.

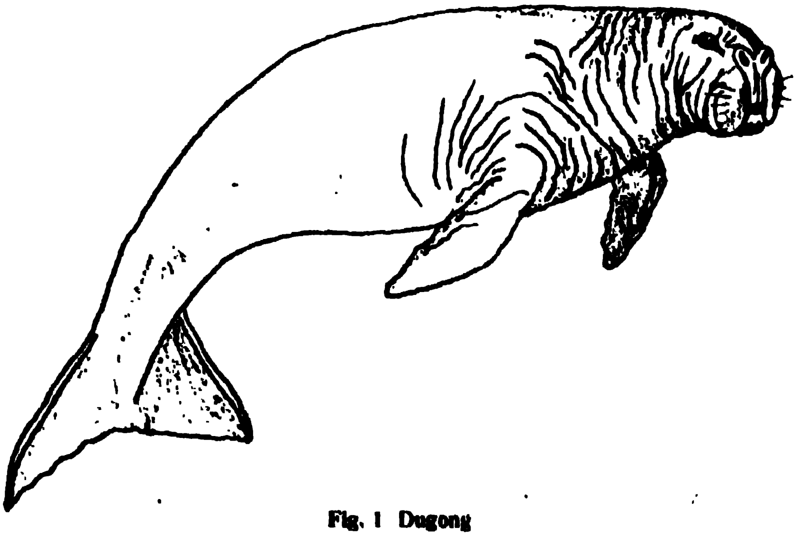

Fig. 1 Dugong

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How does your kite fly ?

BACK in the dim ages of the past, man looked up at the birds and yearned to emulate them. His ambition to imitate the birds soaring in the sky gave him enough courage to use wings made of feathers and jump from a height. The early attempts failed, but nevertheless, aviation history started from these events. The next step to satisfy man's ego was his invention of the kite. Flying a kite is now enjoyed both by youngsters and older people. In some parts of our country it occupies a social status in fairs and festivals. Flight of a kite is based on sound scientific principles.

Let us see how a kite flies. Forces acting on a flying kite are: the thrust due to wind, the tension of the string and its own weight.

Thrust due to wind striking a flying kite at an angle acts on all parts of the undersurface of the kite, but the total effect is equivalent to a single thrust acting at a point (Fig. 1). This single thrust can be taken

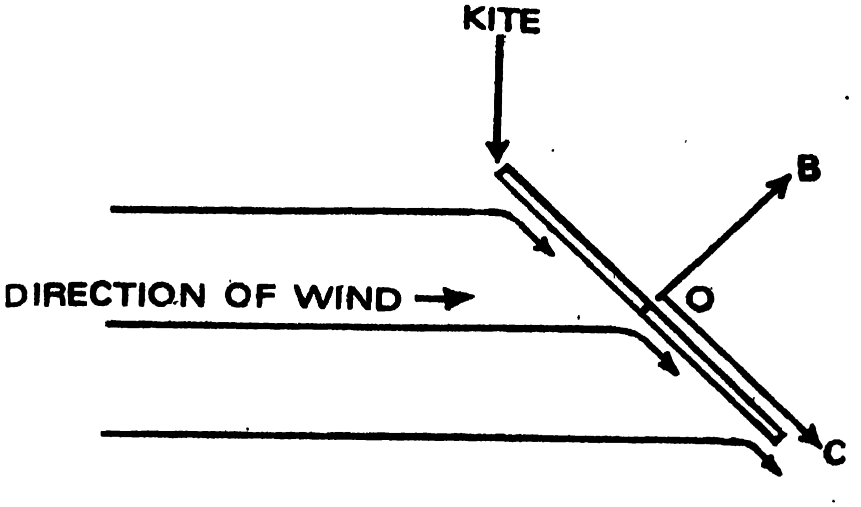


Fig 1

as equivalent to two components, viz., thrust acting along the surface of the kite (OC) and normal thrust (OB). The first component acting along the surface of the kite has no effect on its stability. Therefore, the only effective component of wind thrust is the normal thrust which is responsible for the lift given to the kite. This normal thrust too can be considered to be equivalent to a vertical component which provides lift to the kite in the upward direction, and a horizontal effect that may drag the kite in horizontal direction (Fig. 2).

Normal thrust depends on the relative velocity between wind and kite and also on the angle of inclination of the kite to wind direction. In other words, a strong wind blowing against the surface of the kite will produce the same effect as that when air is still and the kite is moved with a large velocity. Children know this. That is why when the air is still, they run along the ground with the end of the string in their hand. This provides lift to the kite. Another method adopted by them is: one of the playmates takes the kite to a sufficient distance and releases it when it is pulled fast from the other end. As a result, the kite gets a lift.

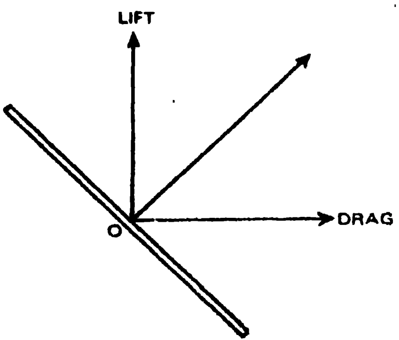


Fig. 2

Thrust is an essential condition of the flight. To get 'lift', there must be 'thrust'. There is yet another condition which is important. The kite must have its nose up and tail down so that its surface is at an angle to the flow of air. The angle (angle of incidence) is produced by adding weight to the kite's tail. Movement of air under the kite, which has its nose up and tail down, would force it upwards. Owing to the angle of incidence, the air cannot blow upon the top surface as it blows against the under-part. As the top is partly shielded from the air flow, at a spot a short distance away from the nose of the kite, there is actually a partial vacuum with practically no air at all. Nature, however, cannot stand even a partial vacuum and its instant efforts to fill it causes the kite move upwards. This suction has been found to be about twice as powerful as the upward pressure of the air underneath. Because of this pressure the kite is lifted high in the air.

The second force is the weight of the kite acting vertically downwards. Weight is the force that retards lift. To keep the weight light, kites are made of thin sheets of paper.

Tension is the third force acting on the kite. The string of a flying kite remains under tension. Tension of the string also acts in two directions, viz., vertical and horizontal. The vertical component of the tension acts downwards and tries to pull the kite vertically downwards. The horizontal component balances the horizontal effect of thrust due to drag of wind.

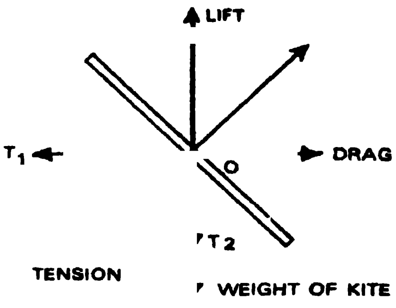


Fig. 3

When the kite is stable in air, lift-thrust acting on the kite is equal to the weight of the kite and the vertical downward tension in the string. Similarly, the force which makes the kite drift horizontally is neutralized by the horizontal component of the tension of the string acting in the direction opposite to that of the drift force.

If the string is pulled, the kite rises. This is because pulling of thread increases the wind velocity relative to the kite. Consequently, the lift force, which depends on the relative velocity between wind and kite, increases and may exceed the downward force, viz., the weight of the kite and the downward vertical component of tension acting on the kite. This excess of lift force over the vertical downward force raises the kite high.

If the thread is loosened, the kite moves farther away. This is because when the thread is released, tension decreases and consequently its horizontal component also decreases. Under these conditions, drag-thrust dominates and pulls the kite horizontally.

Sometimes the wind is gusty or variable in direction. The pressure is liable to sudden variations which produce irregular movements of kite. These effects are reduced by attaching a long tail to the kite which acts as a brake to sudden movements. The tail may therefore be called a stabiliser.

The principle in kite flying closely resembles that of an aeroplane in flight.

R. K. BHATNAGAR
Science Officer, AIR
New Delhi

---

5. Physical or chemical agent which causes a sudden, heritable change.
6. Amino acid is the—of protein.
7. A prominent paddy variety.
8. Central part of a plant.

D. TAGORE SINGH
V. R. KAUNDINYA

(*See solution on page* 794)

Science wheelword puzzle

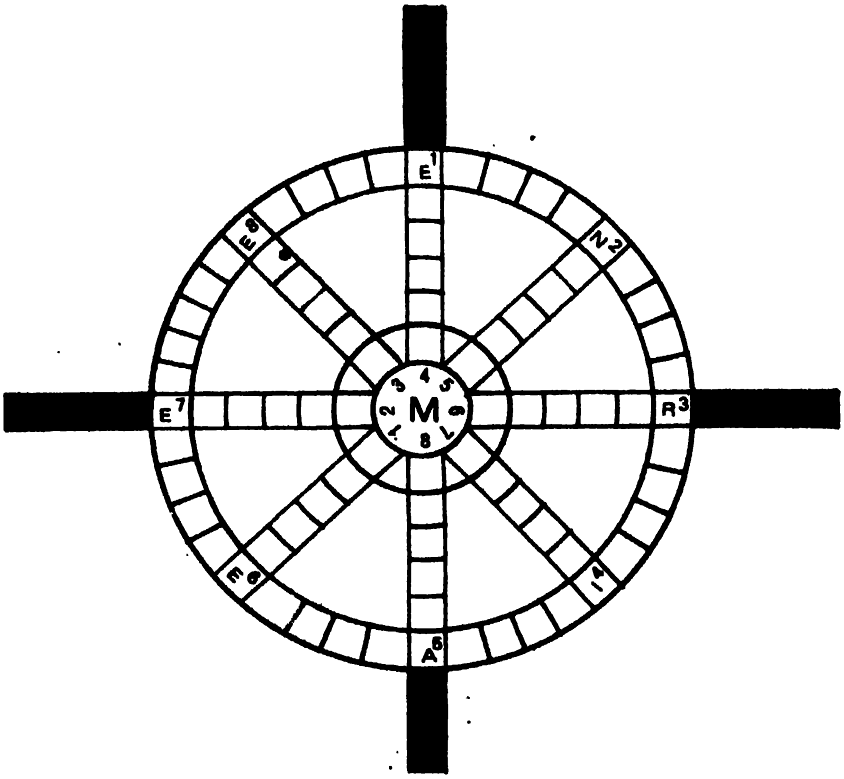
CLUES

The rim (clockwise)

1. Most widely used insecticide.
2. A pasture grass.
3. A mango variety.
4. Endothelium lining of vertebrate blood vessels.
5. One of the two or more alternate forms of a gene.
6. To remove or cut out.
7. A genetic element that can exist either free or as a part of the normal cellular chromosome.
8. An organic catalyst.

The spokes (Axlewise: The words begin from the common axle M)

1. Pertaining to the fauna and flora of the mountains.
2. Sugar formed as a result of starch breakdown.
3. Having the capacity of undergoing a sudden, heritable change.
4. A sub-family to which "Touch-me-not" belongs.



Fun with mathematics

THERE are many curious sums and products of numbers which fascinate everyone.

$37 \times 3 = 111$ and $1 + 1 + 1 = 3$
$37 \times 6 = 222$ and $2 + 2 + 2 = 6$
$37 \times 9 = 333$ and $3 + 3 + 3 = 9$
$37 \times 12 = 444$ and $4 + 4 + 4 = 12$

Here are a few products:

$1 \times 8 + 1 = 9$
$12 \times 8 + 2 = 98$
$123 \times 8 + 3 = 987$
$1234 \times 8 + 4 = 9876$, and so on.

Also

$1 \times 9 + 2 = 11$
$12 \times 9 + 3 = 111$
$123 \times 9 + 4 = 1111$
$1234 \times 9 + 5 = 11111$, and so on.

And

$9 \times 9 + 7 = 88$
$98 \times 9 + 6 = 888$
$987 \times 9 + 5 = 8888$, and so on.

These are the interesting properties of number nine. Thus number 9 plays an important role in multiplication and division.

Guess why

Here is another amusing trick with numbers. Write down any three digit number. Repeat the digits in the same order and make a six digit number (e.g. 312312). Divide the number by seven and take the quotient. Do not worry about the remainder, for there will be none. Divide the result by 11 and then by 13 and we have the original number. Can you guess why ?

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Science oddities

NO other living organism on earth can perhaps match the virtual indestructibility and wide distribution of bacteria. Bacteria can be freeze-dried or kept at the temperature of liquid nitrogen (—195°C) without any apparent harmful effects. Some are unaffected by the passage of electric current through them, or even by strong atomic radiation. Anaerobic bacteria can live only in the absence of air. Some others relish such peculiar habitats as petroleum, acetic acid, and saturated solutions of salt. In fact, bacteria can be found in some of the most extraordinary surroundings that you can think of. While some of them live and breed happily in hot water springs, where temperatures are between 90°C and 100°C; others are found thirty meters below the ice at South Pole.

A man standing still at a point on the equator would certainly be astonished if someone told him that he was rotating, revolving, and gyrating at top speed, as well as taking part in several other movements. But this is actually true, for, the earth under him is moving at a speed of 1680 km per hour around its axis, while at the same time it is revolving around the sun at 105, 600 kmph. What's more, it is moving with the sun at about 68,400 kmph towards the star Vega, while it follows the sun around the hub of the Milky Way galaxy at nearly 864,000 kmph. And, of course, it is moving with the Milky Way, in the galaxy's own motion, but no one knows yet, at what speed, or in which direction.

A cobweb, dusted away by the flick of a duster, may give the impression of a small mat of fine, delicate strands. But, for all its apparent delicacy, spider silk is one of the strongest material in nature. It has been estimated that the tensile strength of spider thread is "second only to that of fused quartz." The natives of Papua, who had for centuries known the strength of spider silk, get their fishing nets made by spiders. A bamboo strip, bent like a tennis racquet, was left in the bush to be converted overnight into a hand-net that could hold upto two kilograms of fish!

IF anyone claimed that he could see around a corner, no one would believe him, for everyone knows that light travels in straight lines. However, this is not as impossible as it sounds, for light can now be made to travel along a curved path by the use of special glass fibres. These extremely fine fibres of glass are flexible. They are so constructed that light entering one end of the fibre is reflected by total internal reflection along the inner walls till it reaches the other end. Using such fibres, it is possible to see around a corner.

QUITE a few plants feed on insects and other small creatures. But the tiny predacious fungi that live on eelworms are a class by themselves, for these weird plants actually set up noose snares to catch their prey. Their bodies

(Continued on page 794)

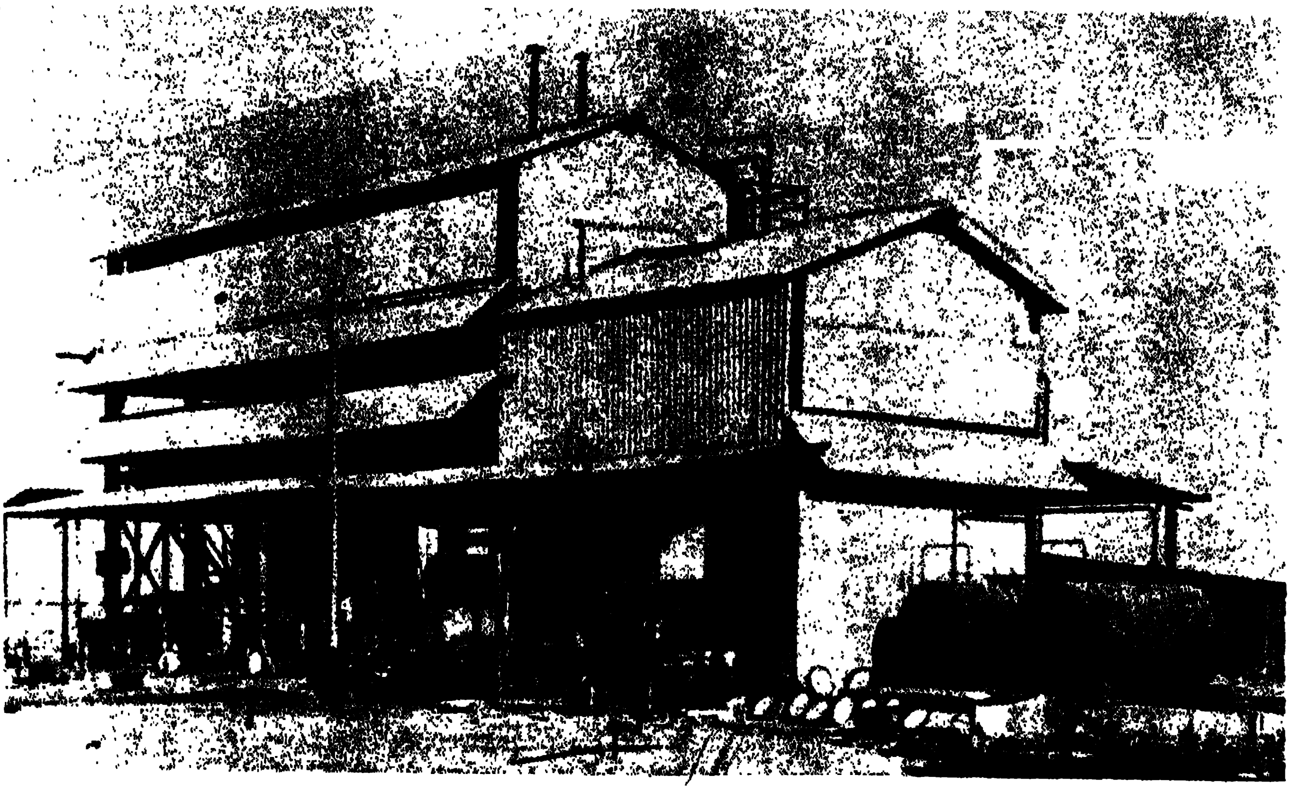
Science in Industry

Export of micro-waxes

FOR the first time in the country, microcrystalline waxes based on Indian Institute of Petroleum (IIP) know-how are being exported by Oil & Natural Gas Commission (ONGC) to various developed countries such as U.S.A., U.K., etc. ONGC has recently exported the first consignment of 20 tonnes of microwax to a firm in Los Angeles through the State Chemicals and Pharmaceutical Corporation, earning foreign exchange to the tune of one lac rupees. Orders for export of microwax to other developed countries such as U.K., Germany, Japan, etc., have also been secured. ONGC has set up a plant at Ankleshwar, costing about Rs. 20 lacs and with a production capacity of 20 tonnes per month. They are planning to step up its capacity in view of the increased demand abroad. It is interesting to note that microwax is being produced from tank bottom sediment of the Ankleshwar crude oil, which had so far been considered 'just waste'. These waxes have 90°C-93°C melting point, and are used in the manufacture of polishes, rust preventives, electrical insulation, paper coating, leather treatment, etc. IIP scientists K. M. Agarwal and Y. Kumar recently visited the Ankleshwar plant at the request of ONGC to help in improving the quality of the product.

The process developed by IIP from pilot plant studies of Ankleshwar tank sediments in its laboratories at Dehra Dun involves recovering and purifying microcrystalline wax from the bottom sediment accumulated in the crude oil storage tanks. This is a waste product obtained during the production and pumping out crude oil.

The accumulations in tank bottoms are melted, thereby removing water and sediment by setting. The lighter fractions like naphtha, kerosene and gas oil are removed by distillation under vacuum, and then the residue is treated with sulphuric acid to remove asphaltic matter. After removing the acid sludge, the acidified wax is treated with sodium carbonate and activated charcoal for neutralisation and decolorisation, and finally filtered through a pressure filter. The molten wax is then passed through flaking machine and microcrystalline wax is obtained in the form of flakes.



Microcrystalline wax plant at Ankleshwar based on IIP knowhow

Manufacture of special charcoal blocks

A process for the manufacture of special charcoal blocks from indigenous raw materials for polishing metal surfaces has been developed by the Central Fuel Research Institute (CFRI), Dhanbad. The main product is the charcoal block and the byproducts are wood tar, liquor and gases. The charcoal block produced by this process is of a special nature and is suitable for polishing metal surfaces. From the liquid products, a number of chemicals, viz., wood preservatives, methyl alcohol and acetic acid, can be made. The gas can be used as a fuel.

About 650 charcoal blocks were consumed during 1975-76. At present the entire demand is being met by imports. The demand is expected to go up.

The wood available indigenously is cut to desired size according to the requirements of the consumer. The wood pieces are carbonized in externally heated metal retorts, the heating being done either by gas or electricity. The gases evolved are cooled in a condenser to separate the liquid products, namely tar and liquor, and the stripped gas is collected in a gas holder and used as fuel. The laboratory carried out work on a scale of 4 kg/batch. The yield of charcoal is 30%-33% on dry wood weight basis. Kail variety of pine wood grown in high altitudes (Kashmir, Himachal Pradesh, Kumaon and Bhutan) is raw material for the process.

The equipment required are: machines for sizing the wood as per requirements, a furnace capable of giving the desired heating schedule; and mild steel retort assembly. All these are available indigenously.

It is suggested that a plant carbonizing 800 kg of wood per annum (300 working days) will be economical. The estimated capital investment for such a plant would be around Rs. 20,000 and the cost of production, Rs. 19 per block.

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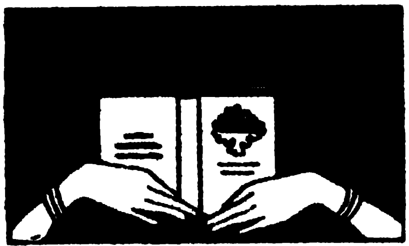

BOOK REVIEWS

LUNAR SCIENCE: A POST APOLLO VIEW *by* Stuart Ross Taylor, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OBW, England, $19.

THIS book is a readily assimilable digest of the vast amount of new knowledge—much of it barely four years old—about our nearest celestial neighbour, the moon. It is remarkable how little, relatively speaking, we knew about this natural satellite of earth barely twenty years ago. At that time there was no way of even viewing one half of moon's surface because it presents the same face towards the earth. The first camera that looked at the moon's averted hemisphere was put into an orbit passing behind the moon in October 1959 by the USSR. Its useful photography was confined to some 70 per cent of the visible hemisphere lit by a high sun, and both the picture quality and the resolution were poor by the standards of earth-based telescopic photography. Useful far-side photographs were obtained from another Soviet space vehicle which completed the lunar far-side coverage in July 1965, and, from a hird, which provided higher resolution coverage of a limited portion of the far-side. A number of craters were readily identifiable, but the most surprising observation was that most of the far-side of the moon contained no maria—the so-called lunar "seas". Major crater chains, upto 1000 kilometres long, were found.

This Soviet contribution to selenology, the science concerned with the physical nature of the moon, is only a minor prelude to the avalanche of knowledge let loose by the Apollo manned landings on the moon by the Americans. There were in all six such lunar landings—the first on July 20, 1969 and the last on December 11, 1972. As a result of these manned landings, a total of 2,196 samples weighing in all 382 kg was collected on the moon. The book under review is a bird's eye view of the scientific return from this amount of material in terms of our understanding of the geology, topography, origin and evolution of the moon as a full-fledged denizen of the solar system. The book consists of seven chapters each one of which, bar the first introductory one, deals with an aspect of lunar science: like Chapter 2 with lunar geology; Chapter 3 selenology; Chapter 4 the "maria"; Chapter 5 the Highlands, Chapter 6 the interior of the moon; and Chapter 7 the origin and the evolution of the moon.

There is no space here to describe the diverse aspects of lunar science dealt with in the book. But there is no doubt that the new knowledge yielded by the analysis of lunar rock samples brought by the manned Apollo missions has provided many scientific surprises. Indeed, each mission was a surprise as the author's own summary recorded at the outset clearly shows:

"Apollo 11 provided unusual chemistry and ancient rocks. Apollo 12 revealed the existence of an extremely fractionated rock type, labeled KREEP, Apollo 14 yielded a plethora of breccias; a peculiar green glass of primitive composition appeared at Apollo 15; Apollo 16, expected by some to sample volcanic rocks found none; while Apollo 17 looking for Cinder Cones, found old orange glasses. The moral, reinforced by our observations on Mars, is that geological processes are different on other planets and that the value of terrestrial analogies and experience is limited."

One consequence of Apollo mission is definite settlement of some old controversies while revealing new aspects of others. A case in point of the first kind is the clear-cut decision that lunar rocks are *not* of volcanic origin but are of "impact" origin, that is, they are caused by the impact of meteorites. An instance of the latter is the origin and evolution of the moon. The new constraints spelled by the Apollo missions have shed new light on the older "classical" theories of the origin of the moon. These "classical" theories of lunar origin are of three main types: (a) Single-shot origin, that is, formation along with the earth as a double planetary system; (b) fission from the earth; and (c) capture by the earth of a body formed elsewhere in the solar system.

None of these three types of theories has survived completely unscathed from their encounter with the Apollo data. But some have been hurt more than others. The biggest injury was suffered by the first type. It was immediately realized from the earliest results that a new set of chemical constraints had appeared to reinforce the formidable dynamical and density problems posed by the existence of the earth's unique natural satellite. Apollo mission data seem to have all but knocked out the first theory because neither the lunar density nor its orbital inclination is in accord with actual findings. It has also been not favourable to the fission hypothesis because it infringes both the geochemical and dynamical constraints. The dynamical objections to it have been known ever since George Darwin first proposed the hypothesis in 1896. But the geochemical constraints are the outcome of Apollo mission data. As for the capture hypothesis, the Apollo data have shown that the moon was not a sample of the primitive solar nebula, as once hoped. Nevertheless, it remains a strong contender. These and other topics in newly arisen moon science have been lucidly dealt with in this book. It is an indispensable acquisition for all who wish to remain *au fait* with the proliferating lunar research of today.

JAGJIT SINGH

COSMIC RAYS *by* A. M. Hillas, *Pergamon Press* (address as above), Pp. 297, $ 12.00.

THE subject of cosmic rays usually deals with the study of the nature and origin of high energy particles (or rays) which reach the earth's surface/atmosphere from above. Beginning with the use of a crude apparatus like the gold-leaf-electroscope in the early part of the present century, it grew into one of the most sought-after fields of physics in the late forties and the fifties when interest in high-energy physics was at it's peak. In the process it led to the discovery and development of many advanced techniques for detection of cosmic ray particles; the nuclear emulsion technique and the bubble chamber, as well as the setting up of some very high energy machines like the "Cosmotron" and the "Bevatron", to mention a few. Cosmic rays can now claim the credit for the discovery of dozens of elementary particles, and still provide the highest energy particles available to man. The subject has wide applications in many branches of physics. It is natural that such a wide and important field should attract the attention of a large number of capable writers. The present volume is written by a Reader in cosmic physics at Leeds University, U.K.

The book is divided into two parts. The first part is of nine chapters covered in about 135 pages. It traces the development of the subject from the very beginning upto the point where the origin and variation of primary cosmic rays became understood. In essence, it appears to be a "commentary" on the way the subject grew with time. The second part, of about 160 pages, contains a reprint of sixteen key research papers. It allows the reader to have a close look at some of the turning points in the history of the subject.

The style of the book is essentially non-mathematical with plenty of historical details on the development of the subject. The reader is frequently advised to go through the relevant research paper at the end of the book. In the reviewer's opinion, more emphasis has been laid on topics like the origin of cosmic rays and their variational behaviour than on the composition and properties of the particles themselves. Illustrations depicting shower production are completely absent. Discussion on the techniques of detecting cosmic ray particles is also not given. But, still, the book on the whole is well written and contains plenty of information for the newcomer. Some original research papers included in the second half of the book (like the one of Hess describing his famous experiments of 1912 with high-rising balloons) instil a thrill in the reader for the subject. Some of these papers are not even easily available in our research libraries. Teachers and researchers interested in cosmic rays would find the book quite useful. It would also be of use to those interested in subjects like radio-astronomy, space physics and astrophysics. Though in India, it cannot be recommended as a textbook for any class, it's addition to college and university libraries would be welcomed.

NARESH KUMAR

PHYSICS IN INDUSTRY *Ed. by* E. O'Mongain and C. P. O'Toole, *Pergamon Press* (address as above) (1976), Pp. 595, $ 30.

HISTORICALLY, physics was relatively slow to enter industry compared with chemistry. Unlike chemistry, where industrial applications go hand in hand, researchers in physics have established only a weak link with industrial technology. Industry needs people with many diverse scientific skills evolved from initial training in physics, because engineering skills alone are not sufficient to provide the innovation rate needed for continued economic success. The book under review, which is an outcome of a recent international conference held at Dublin organized by the International Union of Pure and Applied Physics and the Irish National Committee for Physics, not only emphasises the importance of studying physics applied to industry but also describes several areas of such applications and distinguishes clearly between the academic physics and industrial physics. Generally, physics students, while being trained in basic physics, miss the opportunity of knowing this aspect of the subject.

The major areas covered are communications and data processing, energy, acoustics, biological applications and the new technologies. The social aspects of the problem are also given due attention. Although based on the proceedings of a conference, where generally the stress on any area is proportional to the number of delegates in that area and not necessarily proportional to the importance of the field, the textbook-like style is maintained by the introductory articles and presidential addresses in each area. They introduce and develop the subject and justify the importance of the field. A beginner will also find it interesting.

In addition to scientific contents, various social and philosophical aspects of the problem have been discussed in the plenary papers of the conference. They include the role of the universities and their interaction with the industry, applied physics in developing countries and its role in the improvement of their economic status. Although most contributors on the latter subject are from other developing countries, the only contributor from India in this conference has presented an analysis of socio-economic problems of education for optimizing creative potential of physics for industry. He has emphasized the need for the development of new teaching methods for physicists opting for industry.

As it happens with most conferences, some papers are included even if they have only a distant relation with the basic theme of the conference. Some papers, such as those on measurements of various physical quantities or some modifications in measuring techniques, fit in more in a scientific journal than in a book of this kind. They may be of interest to only those who are directly involved in those fields.

In spite of these minor shortcomings, one would find that the book is a useful information manual for those who have interest in this field or who are directly involved in the industries in the mentioned areas or those who are policy planners for scientific research.

A. K. GUPTA

INVERTEBRATES *by* R. L. Kotpal, S. K. Agarwal and R. P. Khetarpal, *Rastogi Publications*, Meerut 250002, Pp.660, Rs. 17.50

QUITE a number of books on zoology are available for students of high-school standards as well as of college level, but most of them are written by foreign authors. They deal with animals many of which are not found in India. The basic principles of zoological science, like those of any other science, do not vary with nations; but when we get down to details and specifications, differences arise. Students would like to know more about the animals around them. The authors have taken care to deal with animals specially in India. The value of this book is thus enhanced.

It is a well printed publication, profusely illustrated to make understanding simple. The type sizes are large for easy reading and the language has been kept simple. All these add to the readability of the book. Students of both high-school and college levels will find it useful.

A MANUAL OF VIRUS DISEASES OF TROPICAL PLANTS *by* S. P. Raychaudhury, *The Macmillan Company of India Ltd.*, 2/10, Ansari Road, N. Delhi-110002 (1977), Pp. 299, Rs. 44.25.

THE author is internationally known in the field of phytopathology, particularly virus diseases of plants. It is his persistent interest of three decades that has culminated in this book. The publisher claims it to be the first comprehensive account of virus diseases that affect the plants in the tropics. To some extent it is correct to say so. As the principles of virology can be found in other books, they have been purposely omitted here. The author has described about 250 virus diseases of plants. Using common English names, he has tactfully avoided the controversial nomenclature system.

The first part of the book under review consists of nine chapters spread over 86 pages. In this part interesting aspects are as follows: Some viruses cause morphological aberrations so that the disease caused is recognizable, while others do not. The latter can then be detected by the presence of crystalline or amorphous inclusions in the cells. The viral diseases can be transmitted just by touching, or when plants are grafted, or by the insects that feed on them. Viruses are also transmitted by pollen from the infected plants and by the seeds produced by the diseased plants.

The latest methods of separation of viruses from plant material and their purification, such as differential centrifugation and electrophoresis are described. The serological tests, such as precipitin test, complement fixation test, and electrophoresis described here will be useful for those who are interested in identifying the different viruses. Fluorescent antibody technique used by the author has been helpful in determination of viral infections.

The book also informs the reader how viruses can be controlled. It is interesting to note that by culturing the rapidly growing shoot apices of diseased plants and embryos, one can obtain a disease-free plant. Tissue culture methods also serve as a means of propagating the viruses.

The second part of the book has 15 chapters and deals with infections of the various plants grown in the tropics. Some of the important plants dealt are rice, wheat, maize, sugarcane, cotton, jute, sandal, banana, groundnut, mustard, coconut, cardamom, tea and coffee. From the viewpoint of India's commerce and trade, these plants are very important and it becomes imperative to know about the diseases caused by viruses and their control. The author has devoted the last chapter of this part to infections caused by mycoplasma and rickketsia-like organisms.

Each chapter of the book is followed by references, and a subject index concludes the book.

The 109 black and white photographs of the plates have been satisfactorily reproduced, except for the inversion of one of the plates. However, the colour plates are poorly reproduced. The author—quite surprisingly—seems to have forgotten to give any reference to all these plates in the text. Though the book is subsidised by the Government of India, it is priced high.

As virus diseases cause various degrees of damage to economic plants in India as well as abroad, there is a great need for intensive research. The description and photographs included in the book will be of immense help to anyone interested in identifying virus diseases and knowing ways of their control in the tropical regions.

M. ILYAS

FOOD SCIENCE - A chemical approach *by* Brian A. Fox and Allan C. Cameron, ***Hodder and Stoughton***, London; Indian Representative: *B. I. Publications*, 359, D. N. Road, Bombay 400001, Pp. 380, Rs. 39.20.

WE eat several times a day. It is, therefore, important that we know what our food contains, what its various important constituents are, what happens to them, especially the nutrients, during cooking, and so on. Scientifically, our food is nothing but a combination of complex compounds that undergo chemical changes during cooking, processing and digestion.

Proteins, carbohydrates, fats, vitamins and minerals are the main constituents, important from nutritional point of view. But their amounts differ widely in various foods. So there is need to combine various items so that the meal is nutritionally balanced. But how much of what should one take? There is also the problem of spoilage. Why do some foods keep better than others? What is the principle of preservation? What are food additives? Are they harmful? The answer to these questions and many others can be found in the fourteen chapters of this book.

Food Science is basically a book of biochemistry, but with a difference. Unlike standard textbooks on the subject, here the treatment of the various topics is concise, yet easily understandable. The various food constituents like carbohydrates, proteins, oils and fats, etc., are dealt with in separate chapters while full chapters are devoted to general topics like basic chemistry, food and its functions, cooking and diet, food spoilage and preservation, etc.

There it a lot of interesting bits of information on topics like food values, proper cooking method (from nutritional point of view, of course), dieting (or slimming), food hygine, etc., which the housewife may find useful. Apart from suggestions for further reading at the end of each chapter, there is a general reading list at the end which will be of help to the serious reader.

BIMAN BASU

Books Received

1. **MATHEMATICAL ANALYSIS** by V. Ganapathy Iyer, *Tata McGraw-Hill Publishing Co. Ltd.*, 12/4, Asaf Ali Road, 3rd Floor, New Delhi, 110002, Pp. 360, Rs. 21.00.
2. **ELECTRONIC PRINCIPLES AND CIRCUITS** by A. K. Kama & N. K. D. Choudhury, *Nem Chand & Bros*, Civil Lines, Roorkee-24667, Pp. 686, Rs. 32.50.
3. **ENGINEERING FLUID MECHANICS** by R. J. Garde & A. G. Mirajgaoker, *Nem Chand & Co.*, Pp. 591, Rs. 27.50.
4. **MECHANICAL VIBRATIONS** by G. K. Grover, *Nem Chand & Co.*, Pp. 462, Rs. 20.00.
5. **FORTRAN-IV & ENGINEERING APPLICATIONS** by Satya Prakash Garg, *Nem Chand & Co.*, Pp. 552, Rs. 22.50.
6. **HIGHWAY MATERIAL TESTING (Laboratory Manual)** by S. K. Khanna & C. E. G. Justo, *Nem Chand & Co.*, Pp. 135, Rs. 8.75.
7. **OPTICS** by F. G. Smith & J. N. Thomson, *E.L.B.S. & John Wiley & Sons Ltd.*, C/o British Council Division, 21, Jor Bagh, New Delhi-110003, Pp. 350, £ 1.30.

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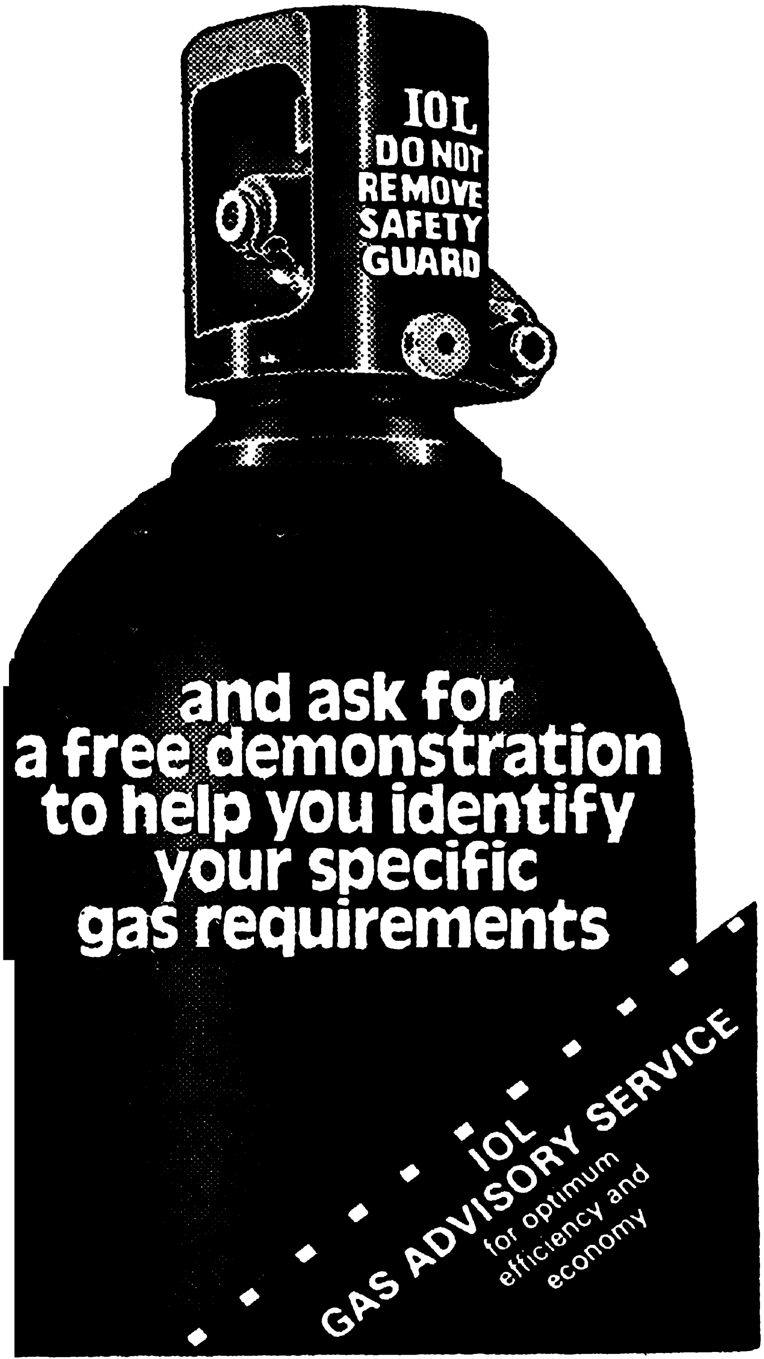

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